COAL

VOLUME IV

PARTS IV, V and VI

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DRAFT ENVIRONMENTAL IMPACT STATEMENT

SITE ANALYSIS

CARTER MINE—KERR-McGEE MINE—WYODAK MINE

Development of Coal Resources in the

EASTERN POWDER RIVER COAL BASIN

of Wyoming

COAL

BLM - USFS - USGS - ICC

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CHAPTER I

DESCRIPTION OF THE PROPOSED ACTION

Background and History

The Carter Oil Company, a subsidiary of Exxon, proposes to mine coal by strip mining methods from federal coal lease W-5036 located north of Gillette, Wyoming in the Powder River Basin (Figure 1).

Current projections call for mining to begin in 1976 and for production to reach five million tons of coal per year by 1978. The coal mined will be transported by unit trains to electric power generating plants in the Midwest where it will be consumed. Capacity of the mine will be such that it can supply a possible coal gasification plant.

Federal coal lease W-5036 was awarded to Humble Oil and Refining Company following a competitive lease sale held August 18, 1967. Humble submitted the high bid of $165.86 per acre or $905,176.00 for the 5,457.47-acre lease. The lease was issued to Humble effective December 1, 1967 and assigned to Carter Oil Company effective July 1, 1969. Carter holds in fee simple title the surface rights to 960 acres of land within the federal lease area, and 120 acres of land adjacent to the lease. Forty acres of land in section 11 of T51N, R72W, are national resource land. The remainder of the surface within the lease is held in fee simple title by private interests. All coal within the boundaries of the federal lease is owned by the United States Government, except for that which occurs in a 40-acre portion of section 6, T51N, R72W, which is leased by Carter from private interests.

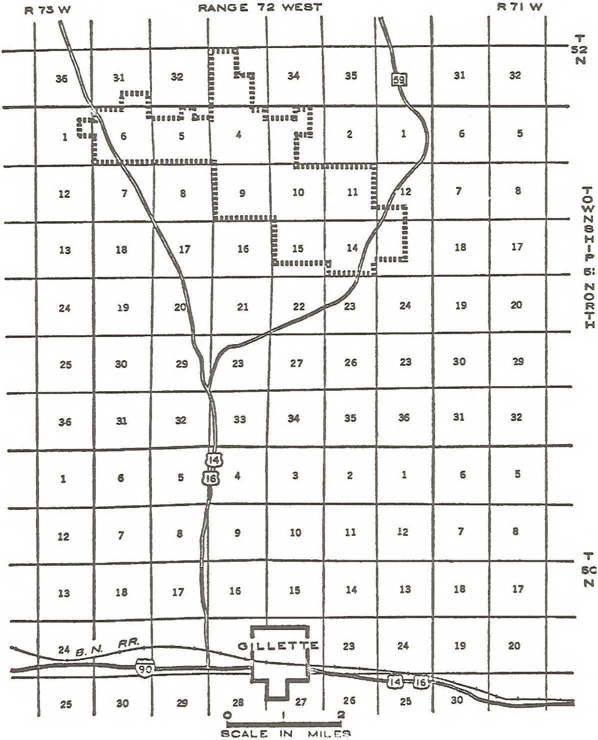


Figure 1

Location of the North Rawhide Coal Property of the Carter Oil Company

Campbell County, Wyoming

The lease area surface and coal ownership is tabulated below.

	Surface	Coal
United States	40*	5,417
Carter	960	0
Other private	4,457	40
Total	5,457	5,457

*Bureau of Land Management

Carter has conducted development drilling programs every year since 1969 to further delineate character and extent of the coal reserves. As a result of this drilling program, a preliminary plan to extract the coal resources from the federal lease was submitted to the area mining supervisor (USGS) on April 3, 1973, with additional data, information, and supplements filed on May 17, May 25, and August 17, 1973.

These plans, along with all supporting data, are being reviewed by the U.S. Geological Survey and the Bureau of Land Management to determine if any additional requirements or stipulations are necessary. The plans are also available for public inspection at the office of the area mining supervisor in Billings, Montana.

The plan submitted constitutes the first proposed development of federal coal on this lease. It is anticipated that mining will ultimately encompass a major portion of the lease. At a production rate of five million tons, mining will disturb an estimated 30 acres per year and an equal amount will be reshaped and planted.

The plan, submitted in accordance with 30 CFR 211, coal mining operating regulations, is intended to maximize recovery of the coal resources

and to provide for successful reclamation and revegetation of the disturbed land area. Pursuant to departmental policy, the plan must comply with the reclamation requirements of the Wyoming Environmental Quality Act of 1973.

Purpose of proposed project

Development of the North Rawhide mine is planned to meet low sulfur coal supply commitments. On January 17, 1974, Carter Oil Company signed a 30-year coal purchase contract with Indiana and Michigan Electric Company, a subsidiary of the American Electric Power Company, Inc., for five million tons per year of low sulfur western coal. Deliveries of coal are scheduled to begin in mid 1976. This coal will be used at a new power plant to be constructed at a location to be selected within the State of Indiana from a number of sites currently owned by Indiana and Michigan Electric Company. Two 1,300-megawatt fossil fuel generating units will be constructed.

Sufficient coal production capacity will be available at the mine to supply additional purchase contracts for power generation or coal gasification.

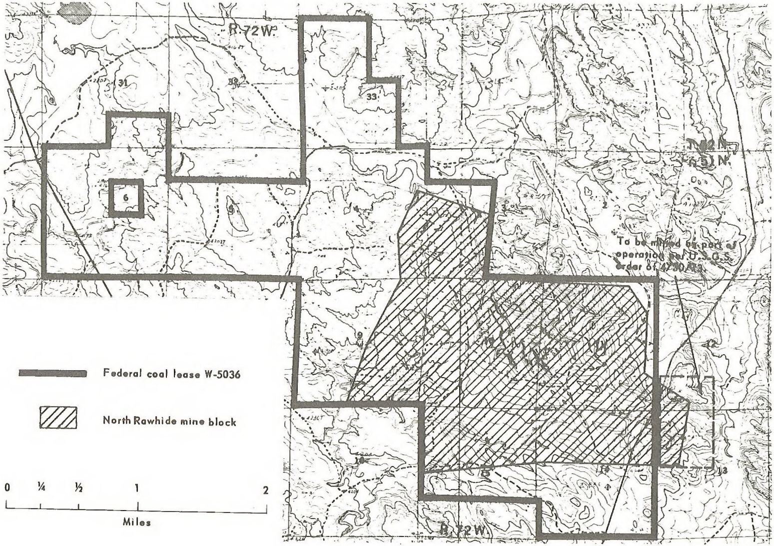
Site location

The Carter Oil Company's North Rawhide block is located 8 to 10 miles due north of the Town of Gillette in Campbell County, Wyoming (Figure 1). The North Rawhide block is designated as the area covered by federal lease W-5036, which includes 5,457 acres, with minor modifications relating to the absence of mineable coal and non-federal ownership. The lease includes all of sections 4, 6, 9, 10, 11, and 14, and parts of sections 3, 5, 12, 15, and 16, T51N, R72W; parts of sections 31 and 33, T52N,R72W; and part of section 1, T51N, R73W.

State Highway 59 provides access to the east side of the lease, and U.S. Highways 14 and 16 provide access to the west side of the lease. The North Rawhide mine block consists of an irregularly shaped area in the eastern portion of the lease bounded by the limits of mineable coal as designated in Figure 2.

Figure 2

Location of North Rawhide Mine Block in Relation to Federal Coal Lease W-5036



Stages of Implementation

Proposed mining procedures and equipment

The mining and reclamation procedures and equipment described in this section are taken, with modification, from the mining and reclamation plans submitted by the Carter Oil Company.

The mining methods and equipment Carter Oil Company proposes to use on their North Rawhide mine were selected by the company based on the economics of earth moving, coal mining, and land grading and reclamation. The methods should also aid in preventing contamination of the coal by spoil material.

The coal reserves to be mined consist of two beds separated by a clay parting ranging in thickness from 2 to 20 feet. The upper bed (Roland) averages 25 feet in thickness while the lower bed (Smith) averages about 82 feet in thickness. These two beds differ chemically and to obtain a uniform product they will be mixed in the pit prior to loading. To accomplish this mixing, a staggered or offset bench system of strip mining will be used once mining has progressed to a point where both beds are present. A schematic of the coal production system is shown in Figure 3.

The company proposes to begin operations to the east of State Highway 59 at the outcrop along the east margin of the lease area in sections 12 and 13 (Figure 4) and advance in a southerly direction until the coal thins and pinches out (facies change). At the start of mining, a boxcut approximately 1,100 feet long (east-west) and 400 feet wide (north-south) will be excavated to uncover about 530,000 tons of coal. Only the Smith bed coal is present in the initial cut because the Roland bed has been removed by erosion in this area. The overburden from the boxcut will be placed outside the area underlain by any strippable coal.

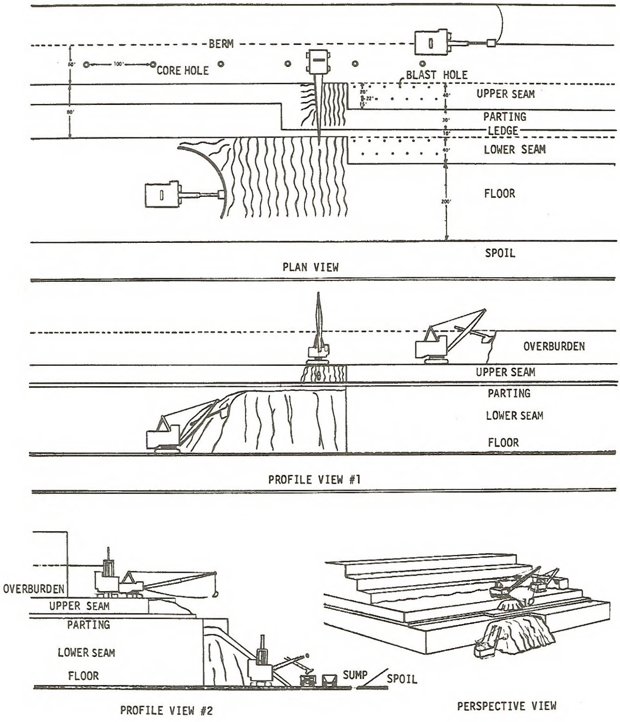


Figure 3
Schematic of Truck and Shovel Overburden Removal and Coal Production Operations Proposed for the North Rawhide Mine.

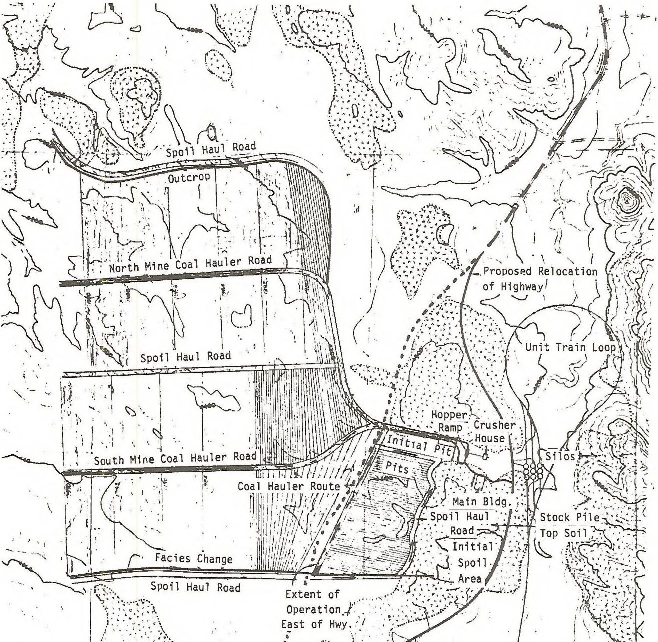


Figure 4

Mine Plan Showing Layout of Surface Facilities for North Rawhide Mine

Overburden from the second cut will be placed in the initial boxcut and that from the third cut will be placed in the second cut. This sequence of mining will continue until mining reaches the facies change line which limits mining to the south. At that time, mining will start toward the west and will continue until the reserves have been depleted. In working to the west, pits will be established north and south of the main coal haulage road so that the company will have two separate pits in which to conduct operations. The coal from the north and south pits will be blended in order to meet EPA standards for utility use.

Coal from the north mine, when mined separately, will not meet EPA standards unless a portion of the upper bed is discarded. As a conservation measure, rather than discard any of the upper bed, it is planned to blend south coal with north coal in such proportions that the product will qualify for utility sales.

When coal demands exceed the capacity of the preparation facilities, Carter proposes to construct additional plant facilities east of the north mine, adjacent to the main haul road. With additional excavation equipment to be purchased at that time, the production capacity of the total mining operations could be increased to 22 million tons of coal per year.

Once sufficient coal has been removed from the initial boxcut to enable equipment to maneuver in the pit, backfilling and concurrent reclamation will begin. As overburden material is dumped on the spoil piles it will be leveled and pushed over the advancing face of the spoil. Motor graders will be used to finish-grade the surface of the spoils prior to redistribution of topsoil and planting. Final highwalls will not be formed

until operations have been underway for many years. The company proposes to reduce highwalls to a slope of 2:1 or less or to whatever degree is required by the operating regulations in force at that time.

All graded and topsoiled areas will be gouged or scarified prior to planting to aid in retaining precipitation and to help reduce wind erosion.

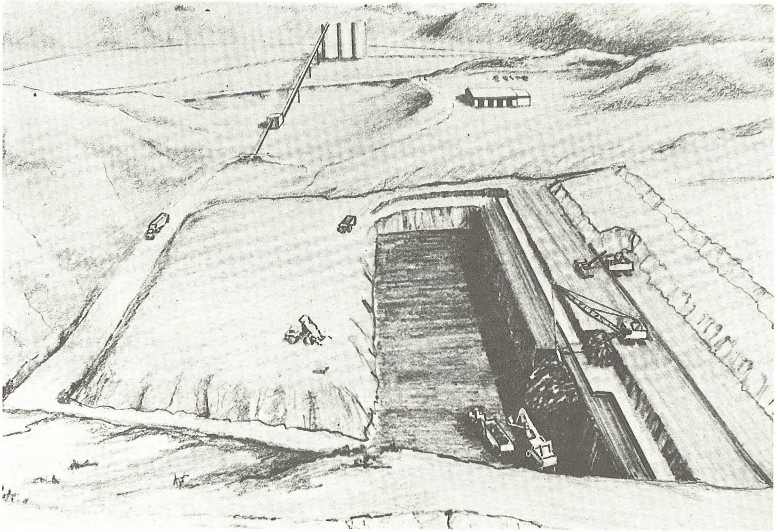
Artists' concepts of the mining and reclamation activities in the initial pit and in the combined north-south pits are shown in Figures 5 and 6, respectively.

Soil material removal

Prior to mining the initial boxcut, all topsoil from the boxcut area and from the initial spoil disposal area will be removed and stockpiled separately adjacent to the initial spoil disposal area (Figure 4). Stockpiled topsoil will be used to cover the initial box cut spoil after it has been shaped. Once mining has progressed to the point where spoil is being dumped into the initial boxcut, topsoil from the unmined area ahead of the highwall will be removed and placed directly on the graded spoil. The topsoil will be distributed over the graded spoil using a scraper. A large motor grader will complete distribution of the topsoil and dressing of the spoil area. Studies are underway by the University of Wyoming, Plant Sciences Division, to determine whether or not a surface layer of topsoil is necessary for the successful establishment of vegetation. It is proposed that the initial spoil area from the boxcut be used for a series of experimental test plots to test vegetation growth with and without topsoil over the spoil.

Figure 5

Mining and Reclamation in Initial Pit Showing Adjacent Facilities, Roads, Silos, and Offices (after Carter Oil Company)



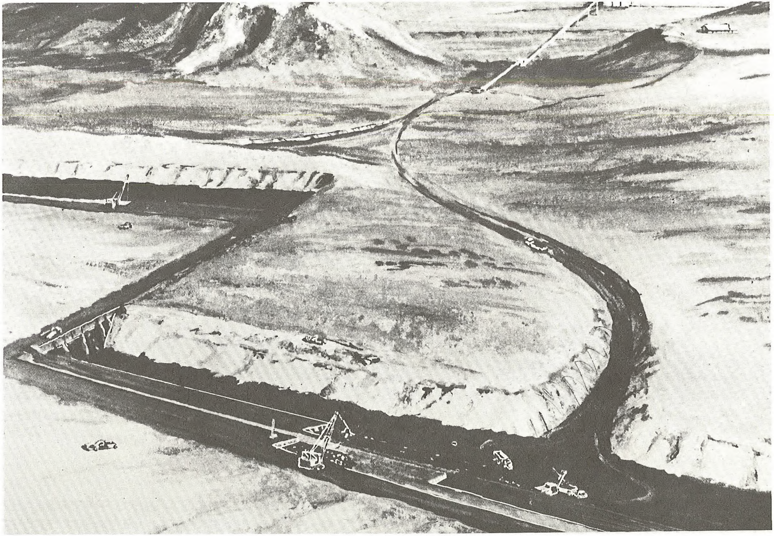


Figure 6

Two Pit Operation of Proposed North Rawhide Mine (after Carter Oil Company)

The Plant Sciences Division is also carrying out a survey of surface soil types within the lease area. They are preparing a map showing the distribution of the soils, and are providing data on the nature and fertility characteristics of each soil type.

Overburden removal

After the topsoil is removed strata or overburden overlying the coalbed will be excavated from the first cut and placed on land outside the mine area from which the topsoil has been removed, but which is otherwise undisturbed (Figure 7). Overburden from subsequent cuts will be used to backfill the pit created by the previous cut.

Overburden removal will be accomplished using electric powered crawler-mounted shovels with 20-cubic yard capacity buckets and 150- to 175-ton capacity off-road rear-dump trucks.

After sufficient coal has been mined from the boxcut, trucks carrying overburden will begin filling the mined-out areas. Once this procedure is established, the backfilling operations will follow the mining operations at a regular distance, allowing approximately 200 feet from the toe of the spoil pile to the coal face.

Based on exploration drilling by the company, overburden above the coal consists mainly of sands and clays of the Wasatch Formation, with some clinker, mainly in the vicinity of the projected coal outcrop line, and alluvial deposits in the valley floors. The Wasatch Formation sediments consist of sands and clays which, unlike the coal seams, are lenticular in cross section and cannot be correlated over wide areas.

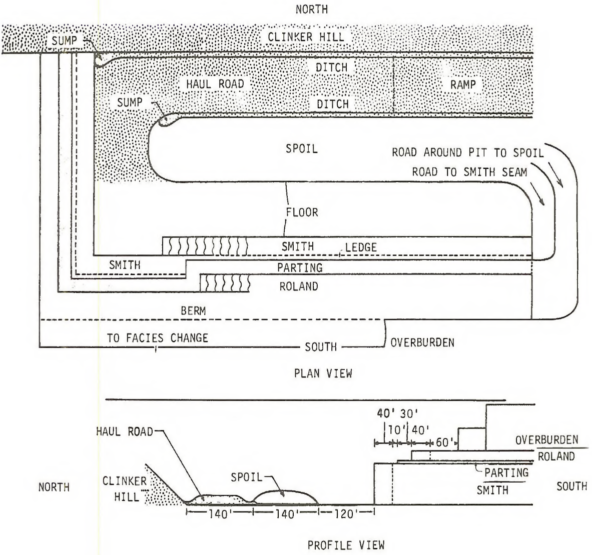


Figure 7

Schematic of the Initial Box Cut Showing Layout of Pit for Truck-Shovel Operation

Overburden materials range in thickness from 20 to 240 feet in the lease area. Figure 8 consists of an isopach map showing the overburden thicknesses throughout the lease area.

At the present time it is not anticipated that blasting will be necessary to loosen overburden material prior to its being loaded by shovels into trucks for disposal in the spoil area.

The company proposes to deposit approximtely 650,000 cubic yards of overburden from the initial boxcut in a ravine between clinker hills to the east of the mineable coal (Figure 4). Commencing at the 4,300-foot elevation, spoil will fill the ravine and blend into the adjacent terrain. The outslope of the spoil will be graded to a slope not exceeding 2:1 (26.6 degrees) and will blend into the adjacent, undisturbed terrain.

Any strata that are particularly suitable for plant growth will be placed on top of the spoil area; any strata containing materials which inhibit plant growth will be deeply buried within the spoils. Preliminary tests on core materials suggest that the only sedimentary layer which is likely to be deleterious to plant growth is the parting between the coalbeds. If further testing, now underway, confirms this, the parting material will be deposited at a low level within the spoil band and covered with more desirable spoil materials.

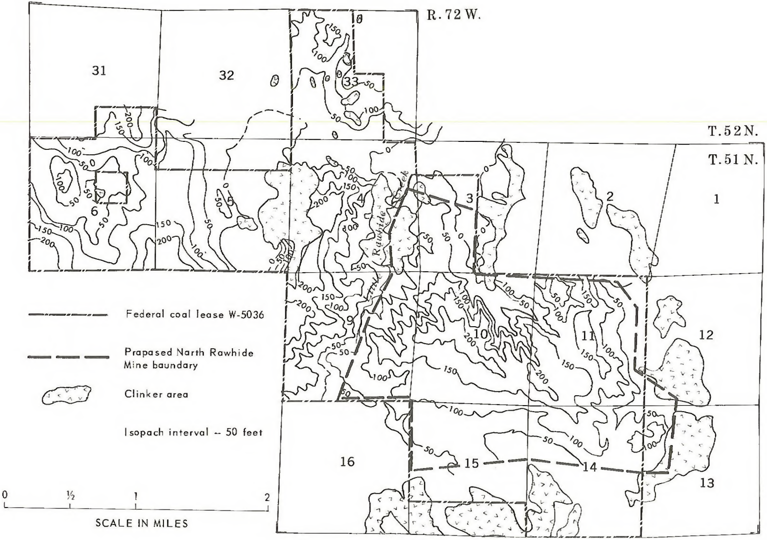


Figure 8

Thickness Map of the Overburden on the North Rawhide Federal Coal Lease W-5036,

Carter Oil Company, Campbell County, Wyoming

Carter plans to operate overburden shovels and trucks on two shifts per day, allowing the third shift for preventative maintenance. Only a few overburden trucks will be required for the first three years of operation, due to the small tonnage and shallow overburden. With increasing overburden thickness and production requirements, demand for overburden trucks and shovels will increase substantially.

Coal removal

Once the north and south pits have been established, coal production from each pit will begin near the main haul road in the center of the pit, and advance outward. This is necessary in order to provide access for equipment to operate on top of the Smith seam.

After the overburden has been removed from above the coalbed the top of the coal will be cleaned by bulldozer or motor grader. Any dirt or slack coal will be pushed off the coal to the floor of the pit and placed against the base of the spoil piles for burial by spoil material as mining progresses.

To provide necessary flexibility in coal production, benches 40 feet in width will be offset between the coalbeds to enable a dragline to operate from on top of the Roland coalbed to remove this coal and the parting between the two beds.

Blasting will be carried out on each bench using two staggered rows of 6-inch-diameter holes drilled on 22-foot centers. The rows will be located 15 feet and 35 feet from the free face. Holes will be charged with a high-density ammonium nitrate-fuel-oil mixture (ANFO) packaged in poly waterproof bags. The holes will be connected with detonating cord and detonated using one electric blasting cap with a 20-pound primer. The

powder factory will vary depending on the thickness of coalbeds, but will typically range from 0.25 to 0.3 pounds of explosives per cubic yard of coal. All applicable safety regulations will be followed in blasting.

After both beds have been shot, crawler-mounted dragline with a 14- or 15-cubic yard bucket and minimum operating radius of 100 feet, will remove the Roland bed from the parting and place it on top of the broken Smith bed. Both beds will then be loaded by electric crawler-mounted shovels with 31-cubic yard capacity buckets into 150- to 180-ton capacity off-road drop-bottom coal haulers. The dragline will remove the exposed parting, casting it to the highwall side of the pit where it will be loaded by the overburden shovels and hauled to the spoil area. As an additional precaution to avoid the loading of parting with the Roland bed coal, a 30-foot-wide berm of parting will be retained to contain the shot Roland bed coal. This will enable the dragline operator to see the surface of the parting at all times while loading the coal. The procedure for excavation of the coal and parting is depicted in Figure 3.

Loaded trucks will move out of the pit along an inclined ramp to the main haul road and thence to the materials handling system for crushing and unit train loading.

Reclamation

Reclamation is the subject of comprehensive studies currently being conducted on behalf of the Carter Oil Company by the University of Wyoming, Plant Sciences Division. The following reclamation plans are preliminary in nature, based on the results of these studies to date, and are subject to revision according to results from further studies. It is anticipated that further revisions and changes in reclamation procedures will

be developed when the results of the initial reclamation efforts have been reviewed.

All reclamation activities will be conducted in accordance with the stipulations and requirements set forth in federal coal lease W-5036, applicable coal mining operating regulations, and any applicable federal, state or local reclamation laws. As more knowledge is gained about reclamation of strip mines in the Powder River Basin, the stipulations and requirements will be modified and expanded to reflect the latest laws, technology changes, and research results. In general, federal lease stipulations require that the mine operator "...take all reasonable steps for the protection and restoration of the non-mineral resources that might be disturbed as a result of his strip mining operation..." and that "the lessee...comply with all state laws and regulations...pertaining to the protection and reclamation of surface resource and the protection of the air and water environment."

The land throughout the leasehold is presently used for livestock grazing. Reclamation of mined lands will be directed toward the restoration of the surface to a condition consistent with this use.

The University of Wyoming, Plant Sciences Division, is currently conducting extensive studies to determine optimum methods for reclamation of the mined areas. These studies include laboratory tests on overburden materials to assess availability of nutrients, soil texture, and presence of toxic elements.

Thirteen typical samples of core materials from exploration drill holes were analyzed by Agricultural Consultants Laboratory of Brighton, Colorado. The results of these analyses are shown on Table 1. Each sample

Hole No.	Depth of Sample (ft)	Sample Description	ph H_2O	ph Salt	CEC (Meg/ 100 g)	Salt (Mmhos/ cm)	Na (Meg/ 100 g)	Lime (%)	Org. Matter (%)	Available Nutrients (ppm) NO_3	NH_4	P	K	Ca	Mg	S	B	Zn	Fe	Mn	Cu
NRH-45C	24-34	Silty Clay (overburden)	8.1	7.7	25	1.3	0.9	6.7	0.8	29	1.2	2.0	210	2500	1000	180	0.6	1.7	13	7.0	2.1
NRH-46C	7-14	Clay (overburden)	8.2	7.5	20	0.7	0.5	0.3	0.9	1.0	0	68	150	2100	720	62	1.3	1.7	50	0.5	6.6
NRH-76C	111.5-119.5	Silty Clay Loam (overburden)	8.3	7.8	15	1.0	0.5	3.1	0.6	9.0	0.3	1.0	140	1700	410	160	0.4	3.3	16	3.2	0.7
NRH-76C	119.5-121.4	Silty Clay	8.7	8.0	15	0.7	0.5	3.7	0.6	11	0.3	1.0	130	1700	410	180	0.6	3.9	15	3.5	0.3
NRH-76C	204-212.4	Silty Clay (Parting between coal seams)	4.9	4.7	73	2.4	1.1	0	5.5	3.0	0.8	1.0	270	2600	790	200	4.8	7.8	50	7.0	8.2
NRH-79C	51-59	Silty Clay Loam (overburden)	7.5	7.4	31	4.2	0.6	2.4	0.8	10	0.4	1.0	160	3900	1100	200	0.3	0.6	18	2.1	0.4
NRH-79C	59-62	Silty Clay Loam (overburden)	7.6	7.5	33	4.2	0.6	1.7	1.3	16	1.0	1.0	160	3800	1400	200	0.2	3.0	10	0.6	1.2
NRH-92C	31-43	Sandy Clay (overburden)	8.1	7.9	24	2.4	0.6	7.9	0.5	4.0	0.1	1.0	160	3200	630	2.0	0.3	0.9	8.8	2.9	0.2
NRH-98C	30-40	Silty Clay (overburden)	8.0	7.8	25	2.4	1.2	5.0	1.6	4.0	0.3	1.0	270	2900	790	200	0.3	2.2	14	6.3	2.2
NRH-99C	120-130	Silty Clay Loam (overburden)	8.3	7.9	19	1.3	1.1	7.7	1.5	10	0.8	2.0	270	2000	620	200	0.3	2.5	37	4.8	1.1
NRH-112C	45-55	Silty Clay (overburden)	8.5	7.9	21	0.8	1.6	5.8	2.2	4.0	0.4	3.0	340	2000	660	62	0.2	3.8	40	11	0.7
NRH-112C	129-137.3	Clay (overburden)	7.4	7.1	13	1.7	1.2	0.5	4.6	1.0	0.2	1.0	280	1300	460	200	0.5	20	46	10	3.2
NRH-126C	171-178.5	Silty Clay Loam (parting between coal seams)	6.8	6.2	11	0.8	1.0	0	4.1	1.0	0.2	1.0	240	860	380	39	0.7	1.6	31	2.0	1.6

Table 1

Analyses of Overburden Materials

was obtained by blending the material from several linear feet of drill core. Samples were selected from several different holes, and at different depths, to represent the different lithologic types present in the overburden and parting. Eleven of the samples represent overburden materials, and two samples are from the parting between the coal seams.

The 11 overburden samples were basic in reaction, having pH values between 7.4 and 8.7. The two samples of parting were acid in reaction; one having a pH of 6.8, and the second having a pH of 4.9. Most core samples appeared to be low in both nitrogen and phosphorus; but from a chemical standpoint, they appear to present no particular toxicity problem. Because of the relatively acidic nature of the clay parting, it is proposed to bury the material in the spoil.

In an attempt to determine stability of the overburden materials under conditions of weathering, samples of each core were subjected to alternate cycles of freezing and thawing, and wetting and drying. Decomposition studies are still in progress but the results so far have ranged from one-cycle decomposition of a silty clay sample to practically no change after three complete cycles on hard sandstone samples.

In addition, representative samples of overburden material are being subjected to biological testing in greenhouse studies at the University of Wyoming to determine their ability to support rangeland vegetation. For these studies, Nordan crested wheatgrass and alfalfa were planted at a rate of 10 seeds per sample of overburden material. All samples studied to date have proven capable of growing Nordan crested wheatgrass and alfalfa. At the end of three weeks, the percentage germination of Nordan crested wheatgrass varied from 31.7 to 93.3 percent while alfalfa varied from 33.3 to

88.3 percent. Further studies will be made to determine appropriate kinds and rates of fertilization.

Because of inherent environmental differences between greenhouse conditions and actual field conditions, the above studies will be supported by experimental test plots at the mine site. The initial spoil area from the boxcut (Figure 4) will be used for a series of trial plots. Some plots will be topdressed with topsoil while others will be seeded without topdressing. These study plots will also be used to experimentally determine optimum rates at which fertilizer should be applied. Design for these experiments calls for one-acre plots with each test repeated four times.

Spoil reclamation

Once sufficient coal has been extracted from the initial boxcut to enable equipment to maneuver in the pit, backfilling will proceed concurrently with mining. Shovels and trucks will remove overburden in front of the advancing highwall and transport it via overburden haul roads to the spoil disposal areas. The spoil will be dumped on top of the spoil pile and pushed by dozers over the advancing face of spoil behind the shovel. In order to provide sufficient room for the operation of equipment, the toe of the spoil will be maintained at least 200 feet behind the highwall.

Most of the shaping of spoil areas will be done by bulldozers moving the spoil into the pit. Any debris and slack coal left by the mining operation will be moved to the base of the spoil piles to be buried beneath the graded spoil. Graders will be used to finish-grade the surface of the spoil prior to topsoil replacement and seeding.

Topsoil, being removed in advance of mining, will be spread over the graded spoil using trucks or scrapers, bulldozers, and graders.

The spoil material must not be allowed to remain in a smooth condition at any time, since a smooth surface is subject to rapid wind and water erosion. Consequently, after the spoil material is shaped and the topsoil spread, the area will be treated with a range pitter or some similar machine to create a rough surface. Such a pitting operation will greatly reduce wind erosion and will allow water to accumulate and infiltrate the surface material. Moisture retained by this treatment will contribute to establishment and maintenance of seedlings from native seed which is in the topsoil. Maintaining a rough surface condition while spoil material is weathering will also eliminate need to stabilize the material by seeding of annual plant species. The seeding of annuals should be avoided because of competition with perennial seedlings which are native or will be introduced. Seeding of annuals, consequently, would reduce the probability for establishment of the more desirable perennial species.

Much of the spoil material is relatively high in clay. If heavy machinery is used on the spoil piles, the clay will generally pack to such a degree that the establishment of vegetation is prohibited. Consequently, it is planned to bury high clay spoil and place more sandy material near the surface. If the spoil material should become severely compacted, it will be ripped prior to application of topsoil.

At the conclusion of mining, the highwall of the final cut will be reduced to a slope not greater than 2:1. Reduction will be accomplished by blasting the highwall and grading spoil back against the highwall. Material from the highwall and the adjacent spoil bank will cover the face of the coalbed and fill the cut. Final grading, distribution of topsoil on the spoil and highwall, and seeding will complete highwall reclamation.

These highwall reclamation procedures are specified to control generation of acid water from the coal and parting clay and to prevent spontaneous or accidental ignition of the coalbeds. The Carter Oil Company will consult with officials of the Bureau of Land Management, Wyoming Department of State Lands, and with the U.S. Geological Survey to determine where further reclamation of the final cut and other mined areas will be needed.

Drainage control

To protect the initial mine area as it advances to the south, a settling pond for surface runoff collection will be constructed at the location shown on Figure 9. Water from this collection pond will move by diversion ditch north to a settling pond where any suspended material will settle out. Other settling ponds are proposed for other drainage areas (Figure 9). A series of coal dewatering holes may be drilled in advance of mining in an area to reduce water inflow into the pit.

The dams to be built for runoff collection and settling ponds will be constructed of compacted earth and will be located down drainage from the mine to help prevent silt from leaving the mine area during periods of heavy runoff.

Diversion ditches and dams will be constructed to the specifications given in Figure 11, Chapter III, Part I.

Spoil piles will be graded to a gently rolling configuration and will be treated when necessary by a range pitter or some similar machine to roughen the surface to improve water infiltration and reduce runoff.

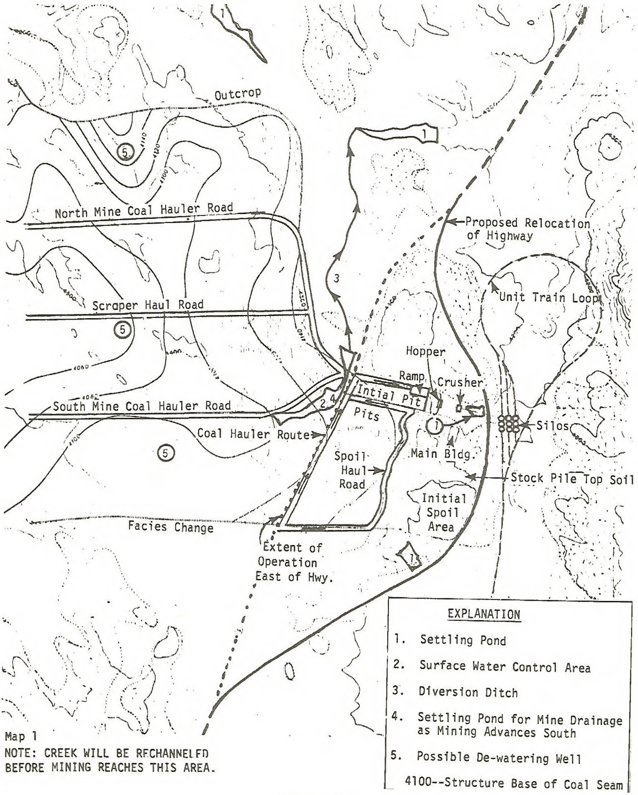


Figure 9

Surface and Subsurface Water Control and Monitoring Structure at the North Rawhide Mine

Seeding and planting

The objective of the reclamation program at the North Rawhide mine will be to return the area to a condition that will sustain livestock grazing and provide a habitat for wildlife indigenous to the area.

With this in mind, University of Wyoming Professor Robert L. Lang's preliminary recommendations are that the area be seeded with Nordan crested wheatgrass (*Agropyron desetorum*) where grazing will be restricted to the spring and fall seasons, and that Russian wildrye grass (*Elymus junceus*) be planted where grazing will be restricted to the summer. The Russian wildrye grass has a less vigorous seedling and is harder to establish than the Nordan crested wheatgrass, but is more palatable year round. Mixing the two species is not recommended because the greater palatability of the Russian wildrye grass would result in selective grazing by livestock at inappropriate times of the year, making it nearly impossible to establish. The vigorous seedling of Nordan crested wheatgrass allows spring and fall grazing without endangering its establishment and continued growth.

Optimum fertilization rates will be determined experimentally by means of onsite study plots. Preliminary recommendations of Professor Lang are that areas with topsoil be treated initially with 40 pounds per acre of phosphate and nitrogen be applied annually at the rate of 40 pounds per acre for 2 to 3 years. In the event that the use of topsoil should prove to be unnecessary, these fertilizers would probably be applied at the same rates, but applications will be made over a greater length of time.

The greatest amount of precipitation occurs prior to the middle of May in this area, and moisture is crucial to establishment of the above grasses. Consequently, seeding must be done early in the spring (prior to

April 15) or late in the fall (after the end of October but before the ground freezes). The chances of successful revegetation are poor if seeding is done at other times of the year. Lang has recommended that both species of grass be seeded at a rate of eight pounds per acre, regardless of soil material used. Seeding will be done with a grain drill having press wheels.

Adequate fencing will be constructed to allow proper control of grazing until rangeland vegetation is satisfactorily established.

Haul road side slopes will be graded to 1.5:1, which is somewhat less than the natural angle of repose of the spoil materials. These slopes will be revegetated in the same manner as the remainder of the mined area. Special techniques, including contour furrowing or pitting and mulching as required, will be used to minimize runoff on these slopes. The company does not plan to revegetate the surface of some haul roads, so that they can provide access to the area for the grazing that will follow the mining activities.

Surface facilities

The Carter Oil Company has developed plans and schedules for development of surface facilities based on the assumption that coal shipments will commence in mid-1976.

They propose to construct the following: access roads to the proposed plant site and initial mine area; a preparation and loading plant; administration block; all necessary facilities for electrical power; water and explosives storage; and a railroad spur from the main Burlington Northern railroad line at Gillette to the site, a distance of approximately 12 miles.

Roads

Roads will be constructed to provide access to the proposed plant site and the initial mine area. Access roads will be constructed on the natural land surface. Leveled roadbed will be surfaced with crushed clinker. Ditches and culverts will provide drainage. All haul roads will be constructed by using compacted overburden material surfaced with crushed clinker. They will be from 60 to 70 feet in width and will be elevated one to three feet above the adjacent ground level to provide good drainage and to minimize snow drifting. Active roads will be continuously maintained by a motor grader. Culverts will be provided where roads cross natural surface drainage channels. Haul road side slopes will be graded to 1.5:1, which is somewhat less than the natural angle of repose of the spoil material, and will be revegetated. Special techniques, including contour furrowing or pitting and mulching will be used as required to minimize runoff on these slopes.

To control dust, which is not only environmentally unacceptable but also damaging to equipment, active haulage roads will be wetted as necessary through the work day by a water spray truck. The water will be pumped from seepage pools in the active mine pit. The porous road material readily absorbs water and runoff will be negligible.

The company proposes to reroute State Highway 59 to the east of the mine area during the initial mining activity. The proposed route is shown in Figure 4.

The company has no plans to revegetate the surfaces of most main haul roads at the completion of mining as they intend to leave these roads for access to the area for post-mining and livestock grazing activities.

Railroad spur

A railroad spur will be constructed from the main Burlington Northern railroad at Gillette to the mine site, a distance of approximately twelve miles. The railroad spur will terminate in a unit train loop located to the east of the plant site (Figure 4). Railroad construction will begin in mid 1974 and will be completed by mid 1976.

If it is determined that weed species should be controlled along railroad rights-of-way by the use of herbicides, applications and formulations will be in accordance with existing state and federal regulations.

Power

Electric power is needed at the mine for operation of draglines, coal-loading and overburden shovels, drill rigs, coal preparation and unit train loading facilities, rock crusher, office, and shop use. Power will be supplied by a Pacific Power and Light Company 69,000-volt feeder line. Voltage will be reduced at a substation to 4,160 volts. Power will be carried to the mine pits by pole-supported service lines. Near the pits, power is fed to the draglines, shovels, and drills through a series of air-brake disconnects, oil circuit breakers, and trailing cables attached to each item of equipment. The location of substations and powerlines has not been determined but when built will be in accordance with acceptable standards to minimize raptor electrocution.

Office and shop

The mine administration block, consisting of offices, shop, warehouse, and change room and bath facilities will be housed in a single one-story steel frame building located between the initial mine area and the

train loading silos. The building will be served by an extension of the mine access road, which also serves as a haulage road for coal going to the dump hopper. Water for domestic and sanitary use will be pumped from shallow wells located near the building. Sewage and other liquid wastes will be treated in a waste disposal system in a manner that conforms to governmental requirements.

Mining equipment

The mining and reclamation equipment for the North Rawhide mine had not been decided upon as of September 25, 1973, but will probably consist of the following types and sizes:

Equipment	Major Use
150-175 ton capacity rear dump trucks	Overburden removal
150-180 ton capacity drop-bottom trucks	Coal hauling
Electric crawler mounted shovel with 20 cu. yd. bucket	Overburden removal
Electric crawler mounted shovel with 31 cu. yd. bucket	Coal loading
Marion Model 195 M electric walking dragline with 14 or 15 cu. yd. bucket	Move upper coal bed to bottom of pit and remove interburden
Rotary drills	Drilling coal
Scrapers	Removal and distribution of topsoil
Bulldozers	Prepare overburden for loading, move and level spoil, clean off coalbeds
Motor graders	Shape spoil, maintain haul roads
Self-propelled water truck	Water haul roads

Loading equipment

Coal will be hauled from the mine to the crushing facility by 150- to 180-ton capacity off-highway trucks. The bottom-dump trucks will discharge the coal into two 300-ton capacity surge hoppers which will feed the primary crushers by reciprocating feeders.

Storage facilities

Crushed coal will be conveyed from the secondary crushers to nine 12,000-ton drive-through silos for gravity loading into rail cars. The gravity loading system will be capable of loading at the rate of 2,400 tons per hour. Outside storage of crushed coal is not planned.

Crushing and processing equipment

Primary crushers will reduce the coal from mine-run size to minus eight inches. Primary crushers will be located beneath the surge hoppers that receive the haul unit discharge. Coal from the primary crushers will be transported by conveyor to a crusher house where secondary crushers will reduce the coal to minus two inches in size, the size specified in the coal purchase contracts.

The crushing areas and transfer points in the coal handling system will be equipped with vacuum dust collectors or water sprays for suppression of dust.

Mining Sequence

The Carter Oil Company proposed to begin operations at the outcrop along the east margin of the lease area and to advance west to fully exploit the coal reserves within the lease. Initial development will consist of a boxcut, the location of which is shown on Figure 4.

An artist's conception of the boxcut mining operation is shown in Figure 5. The initial cut will be approximately 1,100 feet long (east-west) and 400 feet wide (north-south) and will provide 530,000 tons of Smith seam coal as the Roland seam has been removed in this area by erosion. When sufficient coal has been exposed to provide adequate operating clearances for the shovel and haulers, the coal will be drilled and shot. The shovel operator will commence loading coal and ramping the shovel to the base of the Smith seam. Coal haulers will be positioned on top of the coal for loading until sufficient clearance is established at the base of the seam for both shovel and haulers.

When the shovel has loaded all of the boxcut coal, stripping shovels and trucks will have removed the overburden from pits to the south. The coal shovel will begin loading coal from pits in a west to east direction, while advancing the mine to the south. When loaded, the coal haulers will move in a westerly direction to the end of the pit; north along the western margin of the mined area; and then turn east up a ramp out of the pit to the hopper. When the mine has advanced south to the point where a full section of coal is exposed, the proposed coal-loading system, using staggered or offset benches, will be employed. As the mine advances toward the southern limit of mineable coal, benches will be established in the Roland and Smith beds on the western highwall, in preparation for the next phase of mining.

When all of the mineable coal has been loaded in pits to the south, coal-loading operations will transfer to the pre-established offset benches to the west. Loading will commence directly in front of the haul road coming off the ramp into the pit, and move south to where the coal thins and splits. After pits have been established north and south of the main coal haul road and additional production is required, the company plans to purchase other coal-loading and overburden shovels and draglines and operate from two pits. The artist's conception of the mine at this stage of development is shown in Figure 6. Present plans are to operate one coal shovel per shift. The advantage of operating two pits will be that coal-loading operations in one pit will not interfere with the preparation of the other pit for production during the following shift. During the shift, when the shovel is not operating, there will be sufficient time to:

(1) Provide preventative maintenance to the shovel;

(2) Drill, load, and shoot both seams of coal;

(3) Remove the upper seam with the dragline; and

(4) Use a dozer in conjunction with the dragline to remove the parting from the top of the Smith seam.

The south mine will advance to the west until an area is reached where the quality of coal, when blended with north mine coal, will meet fuel standards. With the procedure for mining offset benches and exposing the coal, auger samples for coal analysis can be obtained a day ahead of mining and analyzed to determine the quality of the coal prior to loading. Sulfur isopach maps can be updated on a day-to-day, pit-to-pit basis for future planning. Depending on the volume of coal required when mining is commenced

at the north mine, one shovel and dragline will be moved from the south mine, or additional equipment will be purchased.

When coal demands exceed the capacity of the preparation facilities, Carter proposes to construct additional plant facilities east of the north mine, adjacent to the main haul road. Additional excavation equipment purchased at that time will increase the production capacity of the total mining operations to 22-million tons of coal per year.

Development of the coal in the western part of the lease has not been scheduled. It is anticipated that development procedures and mining methods will be similar to that outlined for the eastern area. If another system for removing overburden is desirable at that time, Carter will resubmit detailed mining plans for review and approval in accordance with regulations then in effect.

Monitoring

In March 1973, a program was initiated to obtain data on surface water in the area of Carter's federal lease. Six staff gauges were installed in various locations on streams passing through or near the lease. These gauges are read by a local rancher on a monthly basis and also during periods of high runoff. Water samples are collected each time the gauges are read and are analyzed for the following: calcium, magnesium, sodium, bicarbonate, chloride, sulfate, silicon dioxide, hardness, pH, turbidity, total solids, total dissolved solids, total suspended solids, and total volatile solids.

Carter also has a continuing program to monitor ground water levels in a series of 11 observation holes within the lease area. Additional holes will be drilled and monitored as part of the program.

The company proposes to carry out two pump tests. Samples will be collected and analyzed for calcium, magnesium, sodium, bicarbonate, chloride, sulfate, silicon dioxide, hardness, pH, total soluble salts, and total dissolved solids. Carter also proposes to carry out an inventory of all springs, wells, and surface impoundments within two miles of the lease area.

Data from all these tests and observations will be used to evaluate the effects on the surface and groundwater as a result of the mining operations.

Two meteorological stations will be installed near the east edge of the lease in the area of the initial mining activity. These stations will be low elevation (15 to 60 feet) installations and will provide a record of wind, precipitation, and air quality.

Auger samples of coal will be taken daily to maintain quality control of the shipped product. Automatic weighing equipment will be installed at the rail loading facility to obtain accurate weights for royalty payments.

Such additional monitoring equipment as may be required to maintain environmental quality will be installed as conditions warrant.

Transportation and Marketing

Coal will be shipped by unit trains via the proposed Douglas to Gillette rail line to electrical generation plants in Indiana. Additional coal contract commitments may be made for the remaining uncommitted reserves on the lease. Transportation to additional markets would most likely be via railroad.

Utilization

The Carter Oil Company has a contract with Indiana and Michigan Electric Company, a subsidiary of the American Electric Power Company, Inc., for five million annual tons of low sulfur coal for 30 years with deliveries commencing in mid-1976.

CHAPTER II

DESCRIPTION OF THE EXISTING ENVIRONMENT

Air Quality

The Carter coal property is located in the Wyoming Intrastate Air Quality Control Region (Figure 2, Chapter IV, Part I).

Wind direction, inversion occurrences, monitoring information, and present ambient air quality are described for the region in Part I, Chapter IV. Present air quality in the area, typical of that described for the region, is estimated to be good.

Topography

The North Rawhide mine of the Carter Oil Company is near the western edge of the northern Great Plains and on the northern end of a broad plateau extending from Gillette to the Cheyenne River. Streams of this broad plateau drain northward into the Little Powder River.

The terrain in the vicinity of the coal lease is characterized by irregular ridges and isolated knobs separated by narrow to moderately wide valleys (Figure 1). Most of the topographic highs surrounding the mining area are related to erosion-resistant clinker or to sandstone channel deposits; these resistant rock at the burnline result in hummocky topography. Small intermittent lakes dot the flat plateau surface.

Major streams meander through alluviated valleys, the floors of which range in width from 500 to 3,000 feet. The predominant direction of drainage is northward. North Rawhide Creek bisects the lease in this direction.

Elevation ranges from a minimum of 4,060 feet in North Rawhide Creek at the north margin of the lease to a maximum of 4,434 feet on a knoll in the southeastern part. The area has over 200 feet of relief between the valley floor and the crests of adjacent ridges. Side slopes are less than 10 percent but locally steepen to over 30 percent.

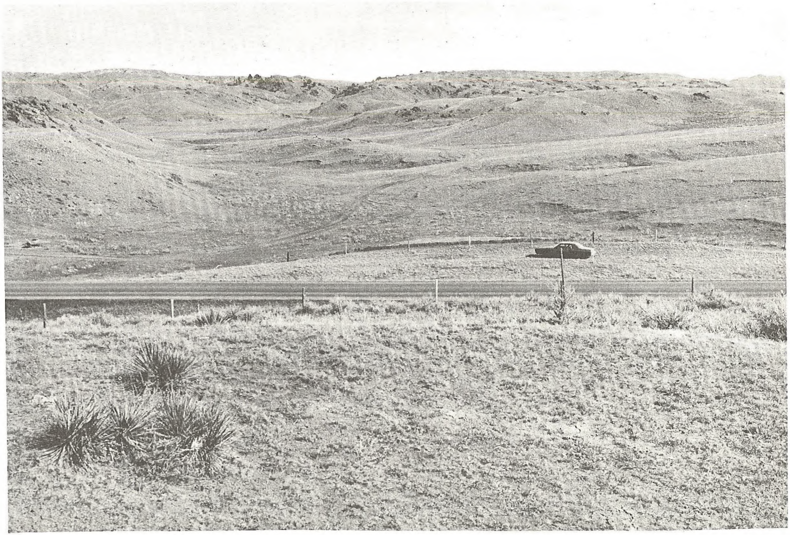


Figure 1

Existing Topography at the Facilities Site and Initial Mining Area of the Proposed North Rawhide Mine

Soils

The Soil Conservation Service completed the field work for a general reconnaissance soil survey of Campbell County in 1939 and published the report in 1955. Although the report identified various soil series, it must be noted that each delineation included several other associated soil series. Therefore, specific interpretations for the identified soil series cannot be applied to the entire delineation shown on the map. The SCS has informed us that many of the soil series identified in 1955 are subject to change as more detailed data is collected. The 1955 report is adequate for general planning only. The University of Wyoming is conducting soil studies for the Carter Oil Company. Additional detailed soil inventories must be conducted upon the mining area to evaluate each soil taxonomic unit.

Based upon the 1955 reconnaissance soils report, ten major soil mapping units occur on the mining lease area. Although each of these mapping units was not studied nor mapped individually in 1939, an estimate of their suitabilities and limitations is discussed in Table I, Soil Management Interpretations. Tables 10 through 28, Appendix C, give a description of each soil series and list their physical, chemical, and management characteristics. A general soils map, illustrated in Figure 2, locates the soils occurring within the mining plan area. A brief summary and acreages for the ten major soil types follows.

The Arvada soil types occur on approximately 200 acres. These soils occur on sloping terraces and alluvial fans. They are shallow (20"), strongly alkaline, and very high in exchangeable sodium. Productivity is very low and present erosion is high. These soils are unsuitable for agricultural use, road fill, building construction, and other uses.

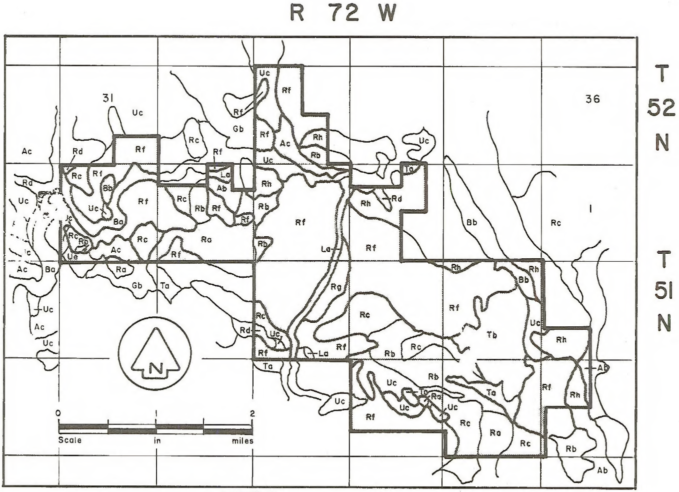
SOIL UNIT Symbol	%Slope	EROSION HAZARD POTENTIAL ** Water	Wind	REVEGETATION POTENTIAL	SUITABILITY FOR SPRINKLER IRRIGATION	SUITABILITY FOR FINAL COVER FOR MINED LAND In, Available	Suitability	SUITABILITY FOR TRANSPORTATION ROUTES	SUITABILITY FOR ROADFILL	SUITABILITY FOR SANITARY FACILITIES Septic-Tank Absorption Fields	Sewage Lagoons	Sanitary Landfills (Trench)	SUITABILITY FOR SMALL COMMERCIAL BLDGS.
Ab	0-5	M	M	L	L	0	L	L	L	L	L	L	L
	5-10	H	M	L	L	0	L	L	L	L	M	L	L
Ac	0-5	M	M	L	L	0	L	L	L	L	H	L	L
Ra-Rb	0-5	M	M	M	L	6	M	L	L	L	L	L	L
	5-10	H	M	M	L	6	M	L	L	L	L	L	L
Rc	10-20	H	L	M	L	6	M	L	L	L	L	L	L
	20-30	H	L	M	L	6	M	L	L	L	L	L	L
	30-40	H	L	M	L	6	M	L	L	L	L	L	L
Rd	0-5	M	M	M	M	8	H	L	L	L	L	L	L
	5-15	H	M	M	M	8	H	L	L	L	L	L	L
Re	10-20	H	L	M	M	8	H	L	L	L	L	L	L
	20-30	H	L	M	L	8	H	L	L	L	L	L	L
	30-40	H	L	M	L	8	H	L	L	L	L	L	L
Rf-Rg	20-30	H	L	L	L	0	L	L	M	L	L	L	L
	30-40	H	L	L	L	0	L	L	L	L	L	L	L
	40-50	H	L	L	L	0	L	L	L	L	L	L	L
Rh	20-30	H	L	L	L	0	L	L	M	L	L	L	L
	30-40	H	L	L	L	0	L	L	L	L	L	L	L
	40-50	H	L	L	L	0	L	L	L	L	L	L	L
Ua	0-5	M	M	L	L	6	M	L	L	L	L	L	M
Ub	5-10	H	M	L	L	6	M	L	L	L	L	L	M
Uc	0-5	M	M	M	M	16	M	M	M	L	L	L	M
	5-10	H	M	M	M	16	M	M	M	L	L	L	M
Ud-Ue	0-5	M	M	M	M	16	H	M	M	L	L	L	M
	5-10	H	M	M	M	16	H	M	M	L	L	L	M
Wa	5-10	H	L	L	L	8	L	M	H	L	L	L	H
	10-20	H	L	L	L	8	L	L	H	L	L	L	M
	20-30	H	L	L	L	8	L	L	M	L	L	L	L

* - 3 Classes - L - Low, M - Moderate, H - High.

** - Estimated on-site erosion, bare soil conditions, L - 3,%./ac, M- 3-8 T./ac., H - 8T./ac.
Source of interpretations: 1. Descriptions from Campbell County. 2. Soil Conservation Service soil profile descriptions. 3. S.C.S. Form 5, Interpretation sheet. 4. Region 2, F.S. Guidelines for Soil Interpretations. 5. S.C.S. Guide for Interpreting Eng. Uses of soils.

Table 1

Carter
Soil Interpretation Summary *



LEGEND

SYMBOL	SERIES	SYMBOL	SERIES
Ab	Arvada Clayloam	Rc	Renohill rolling phase
Ac	Arvada loam	Rd	Renohill loam
Ba	Bankard fine sandy loam	Re	Renohill loam rolling phase
Bb	Satanta very fine sandy loam	Rf-Rg-Rh	Rough Broken Land
Gb	Unnamed	Ta-Tb	Terry sandy loam
La	Haversan clay loam	Ua-Ub	Ulm clay loam
Ra	Renohill clay	Uc-Ud-Ue	Ulm loam
Rb	Renohill clay loam	Wa	Wilbaux-Searing complex

Source: USDA, Soil Conservation Service, Soil Survey, Campbell County, Wyoming July 1955, Soil Map, Sheet No. 3 8 4

Fig. 2
General Soils Map (Carter Coal Property)

The Renohill soil types occupy nearly 1,800 acres on gently sloping to rolling uplands underlain by weathered shale at depths of 20 to 40 inches. Soil reaction is moderately alkaline at 6 to 20 inches. Internal drainage is slow due to the clay subsoil. Productivity for native vegetation is medium, ranging from 750 to 1,800 pounds per acre dry weight. Agricultural use is limited due to shallow depth to bedrock and alkalinity. Present erosion condition is high. Erosion hazard increases to very severe if vegetation or protective cover is removed.

A miscellaneous land type, known as Rough Broken Lands, occupies nearly 2,500 acres. These lands are steep, eroded, and strongly dissected along escarpments and steep-walled drainage channels. Fragments and blocks of red shale, scoria land material, and clinker are scattered on the surface. They are highly eroded, not suitable for agriculture, and productivity is low for native vegetation.

The Terry soil type occupies nearly 600 acres and occurs on moderately sloping to steep sidehill slopes. Depth to bedrock is 20 to 30 inches. Present erosion condition is high. Erosion hazard is high due to the steep slopes and fine sandy loam textures. Productivity for native vegetation is medium, yielding about 1,000 to 1,500 pounds per acre total dry matter.

The Ulm soil types occupy nearly 500 acres situated on rolling to steeply sloping uplands that are strongly dissected by gullies. Depth to bedrock ranges from 10 to 20 inches. Productivity is fair, yielding approximately 500 to 1,500 pounds per acre total dry vegetative matter. Present erosion is high.

The Satanta soil type occupies approximately 120 acres on nearly level to undulating sloping uplands and high terraces. These soils formed

from eolian materials reworked by wind action. Wind erosion hazard is high. Productivity is high, ranging from 1,800 to 2,500 pounds per acre total dry weight. Soil reaction is neutral to alkaline.

The remaining 80 acres are occupied by other soils with few acres as identified in Figure 2.

Summarily, the soils occurring within the Carter lease area are moderately to highly susceptible to wind and water erosion if the vegetation is removed and topsoil disturbed. The revegetation capabilities are poor due to high alkaline or sodium concentrations. Although present native vegetation is sparse, it is tolerant to the salt concentrations and able to provide a protective plant cover against wind and water erosion. As these soils are derived from shale parent materials, they have a moderate to high shrinkswell potential and are highly susceptible to compaction. These two factors, coupled with low infiltration and permeability rates, increase the hazards for erosion, revegetation, water runoff, and flooding, and limit their suitability for reservoirs, topsoil for disturbed areas, road fill material, and other construction uses.

Mineral Resources

Stratigraphic and structural relations

The Carter Oil Company's North Rawhide federal coal lease in parts of T51 and 52N, R72 and 73W, is on the gently dipping east flank of the Powder River Basin in Wyoming. This broad regional downwarp, or assymetric structural basin, contains almost flat-lying rocks of Tertiary age in the center surrounded by Cretaceous and progressively older rocks that are upturned on the flanks of the bordering Precambrian-cored mountains--the Black Hills to the east, the Bighorns to the west, and the Laramie Range to the south; northward the basin blends indistinctly with the Great Plains (Figure 11, Chapter IV, Part I). The lease is in the Powder River coal field that was mapped by Stone and Lupton (U.S. Geological Survey 1908). The following descriptions of the geology and coal resources on the lease block have been summarized from their report, from the reports cited in Part I, Chapter IV, and from the information in the mining and reclamation plans proposed by the Carter Oil Company. The poorly exposed surface bedrock is assigned to two Tertiary formations--the Fort Union Formation of Paleocene age and the overlying Wasatch Formation of Eocene age (Figure 9, Chapter IV, Part I). For all practical purposes the top of the Wyodak (Roland) coalbed defines the top of the Fort Union Formation. The contact is rarely exposed because the coal is masked almost everywhere by alluvium or by the red baked and fused rock, commonly called clinker, scoria, or porcellanite, that formed from the overlying shales and sandstone when the coalbed burned sometime during the past. The Fort Union Formation is underlain in turn by the Upper Cretaceous Lance Formation and Fox Hills Sandstone. The base of the Fox Hills, top of the Pierre Shale, is at a depth of almost 4,000 feet below the lease area. Succeedingly older sedimentary formations representing Mesozoic and Paleozoic ages occur between the base of the Fox

Hills Sandstone and the top of the Precambrian igneous and metamorphic rock complex located as much as 15,000 feet below the surface.

The uppermost part of the Fort Union Formation is partially exposed along the northeast edge of the lease block (Figure 2, Chapter I). The Wyodak coalbed and its associated shale parting form the upper 70 to 150 feet of the formation. The company uses the terminology of Stone and Lupton (U.S. Geological Survey 1908) in referring to these as the Roland and Smith coalbeds and an intervening shale. The formation below the coalbeds at the top is composed predominantly of drab-gray and brownish- and bluish-gray carbonaceous clay shale with lenticular beds of yellowish-gray siltstone and fine-grained friable sandstone and a few thin coalbeds. Only coalbeds less than 10 feet thick have been found in holes drilled to 200 feet below the Wyodak bed in the lease area. Brownish-red, highly ferruginous, thin resistant lenticular sandstone beds and hard ferruginous concretions distinctively mark the formation.

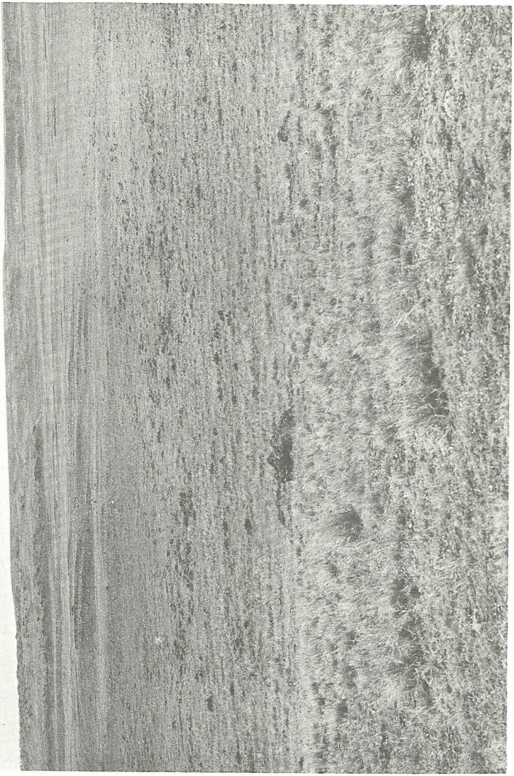
The surface over most of the lease block is underlain by the Wasatch Formation, the overburden to be stripped at the North Rawhide mine. It ranges in thickness from zero feet along the coal crop line on the northeast edge of the lease block to as much as 240 feet in several areas near the center and western parts of the lease (Figure 8, Chapter I). The formation is characterized by fluvial sedimentary beds consisting of light-yellowish-gray, fine-grained, poorly consolidated sandstone, drab-gray soft clay shale, brownish-gray carbonaceous siltstone, and thin coalbeds. In general, the Wasatch Formation in the lease block is composed of about 50 percent argillaceous and silty sandstone, 25 percent clay shale, and 25 percent siltstone. The Wasatch Formation is generally basic, pH values 7.4 to 8.7, and nontoxic as indicated by the analyses of 11 core samples reported in Table 2.

Hole No.	Depth of Sample (ft)	Sample Description	ph		CEC (Meg/ 100 g)	Salt (Mmhos/ cm)	Na (Meg/ 100 g)	Lime (%)	Org. Matter (%)	Available Nutrients (ppm)											
			H_2O	Salt						NO_3	NH_4	P	K	Ca	Mg	S	B	Zn	Fe	Mn	Cu
NRH-45C	24-34	Silty Clay (overburden)	8.1	7.7	25	1.3	0.9	6.7	0.8	29	1.2	2.0	210	2500	1000	180	0.6	1.7	13	7.0	2.1
NRH-46C	7-14	Clay (overburden)	8.2	7.5	20	0.7	0.5	0.3	0.9	1.0	0	68	150	2100	720	62	1.3	1.7	50	0.5	6.6
NRH-76C	111.5-119.5	Silty Clay Loam (overburden)	8.3	7.8	15	1.0	0.5	3.1	0.6	9.0	0.3	1.0	140	1700	410	160	0.4	3.3	16	3.2	0.7
NRH-76C	119.5-121.4	Silty Clay	8.7	8.0	15	0.7	0.5	3.7	0.6	11	0.3	1.0	130	1700	410	180	0.6	3.9	15	3.5	0.3
NRH-76C	204-212.4	Silty Clay (Parting between coal seams)	4.9	4.7	73	2.4	1.1	0	5.5	3.0	0.8	1.0	270	2600	790	200	4.8	7.8	50	7.0	8.2
NRH-79C	51-59	Silty Clay Loam (overburden)	7.5	7.4	31	4.2	0.6	2.4	0.8	10	0.4	1.0	160	3900	1100	200	0.3	0.6	18	2.1	0.4
NRH-79C	59-62	Silty Clay Loam (overburden)	7.6	7.5	33	4.2	0.6	1.7	1.3	16	1.0	1.0	160	3800	1400	200	0.2	3.0	10	0.6	1.2
NRH-92C	31-43	Sandy Clay (overburden)	8.1	7.9	24	2.4	0.6	7.9	0.5	4.0	0.1	1.0	160	3200	630	230	0.3	0.9	8.8	2.9	0.2
NRH-98C	30-40	Silty Clay (overburden)	8.0	7.8	25	2.4	1.2	5.0	1.6	4.0	0.3	1.0	270	2900	790	200	0.3	2.2	14	6.3	2.2
NRH-99C	120-130	Silty Clay Loam (overburden)	8.3	7.9	19	1.3	1.1	7.7	1.5	10	0.8	2.0	270	2000	620	200	0.3	2.5	37	4.8	1.1
NRH-112C	45-55	Silty Clay (overburden)	8.5	7.9	21	0.8	1.6	5.8	2.2	4.0	0.4	3.0	340	2000	660	62	0.2	3.8	40	11	0.7
NRH-112C	129-137.3	Clay (overburden)	7.4	7.1	13	1.7	1.2	0.5	4.6	1.0	0.2	1.0	280	1300	460	200	0.5	20	46	10	3.2
NRH-126C	171-178.5	Silty Clay Loam (parting between coal seams)	6.8	6.2	11	0.8	1.0	0	4.1	1.0	0.2	1.0	240	860	380	39	0.7	1.6	31	2.0	1.6

Table 2

Soil Characterisitcs and Available Nutrients in Samples of the Overburden (Wasatch Formation) from Selected Drill Holes at the Proposed North Rawhide Mine

Typical Basin Land Form



Quarternary alluvium consisting of as much as 25 feet of silty and sandy clay occurs throughout the lease block in valleys along most of the intermittent streams.

Areas of clinker almost surround the proposed mine area on the North Rawhide lease block (Figure 3). Clinker is a red gravelly-textured rock that formed when the strata overlying the coalbeds were baked and fused during combustion of the coal; it is used extensively for road metal and ballast.

The strata on the North Rawhide lease block dip imperceptibly from one to two degrees to the west conformable to the regional structure.

Coal

The Wyodak coal to be mined at the North Rawhide mine occurs in two beds separated by carbonaceous clay shale that ranges in thickness from 2 to 10 feet and averages about 6 feet. At the south boundary of the lease area, this shale increases to more than 100 feet thick (Figure 4). The upper coalbed (Roland) ranges from 20 to 35 feet in thickness except in a zone about 500 to 1,000 feet wide along the eastern and southern crop lines where, because it has been eroded and burned, it ranges from zero to 35 feet in thickness. In general, this upper coalbed thickens in a northerly direction across the proposed mine area (Figure 4). The lower coalbed (Smith) averages about 82 feet thick; it ranges from 50 to 120 feet in thickness except for the zone along the crop line where it is eroded. This lower coalbed generally thickens to the south-southwest, but the bed thins abruptly and lenses-out completely within several hundred feet of the southern boundary of the lease block (Figures 3 and 4). The upper coalbed is continuous through this area of abrupt facies change, but is separated from the lower bed by more than 100 feet of

Figure 3

Thickness of the Coalbeds at the Proposed North Rawhide

Mine, Carter Oil Company, Campbell County, Wyoming

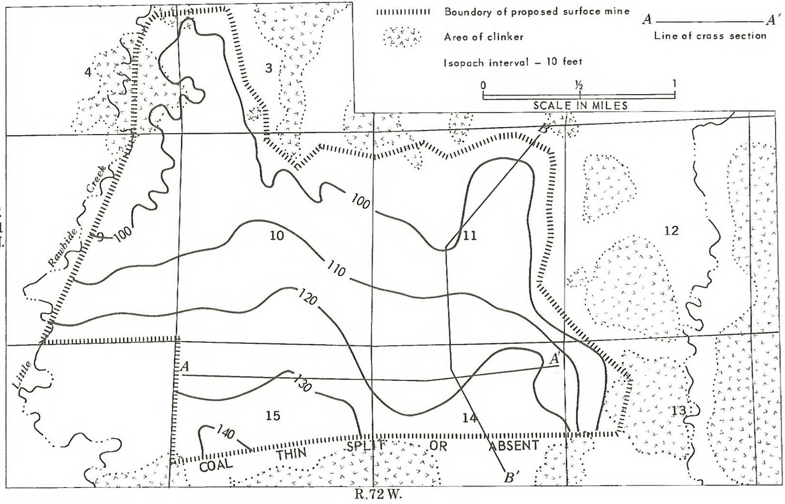


Table 3

Average Analysis of 35 Coal Samples from the Proposed North Rawhide Mine, Campbell County, Wyoming
(All values except Btu and Fusion temperature are in percent. Analyses by Commercial Testing and Engineering Company.)

Proximate Analysis

	As Received	Moisture Free
Moisture	31.00	--
Ash	5.96	8.64
Volatile Matter	30.05	43.55
Fixed carbon	32.78	47.51
Btu	8063	11686
Sulfur	0.38	0.55
Alkalies as Na_2O	0.13	0.19

Ultimate Analysis

	As Received	Moisture Free
Moisture	31.00	--
Carbon	46.81	67.84
Hydrogen	3.25	4.71
Nitrogen	0.66	0.96
Chlorine	--	--
Sulfur	0.38	0.55
Ash	5.96	8.64
Oxygen	11.94	1730

Fusion Temp. of Ash °F

	Reducing	Oxidizing
Initial Deformation	2147	2212
Softening (H=W)	2178	2234
Softening (H=½W)	2192	2249
Fluid Temp.	2215	2279

Oxide Analysis of Ash

Phos pentoxide P_2O_5	0.52
Silica Si O_2	34.93
Ferric oxide Fe_2O_3	6.02
Alumina Al_2O_3	16.64
Titanium TiO_2	1.02
Lime CaO	20.68
Magnesia MgO	4.62
Sulfur trioxide SO_3	14.65
Potassium oxide K_2O	0.51
Sodium oxide Na_2O	1.11

shale (Figure 4). An ancient erosion channel subsequently filled with sediments has been suggested as an explanation for the abrupt termination of the coalbed in this area (U.S. Geological Survey 1973).

The thickness lines shown on Figure 3 are for the combined Wyodak coalbed excluding the interbedded shale. The thickest coal is along the south edge of the proposed mine area adjacent to the abrupt thinning and facies change in the coalbed.

Quality of the coal

The analyses supplied by Carter Oil Company show that the coal to be produced at the North Rawhide mine is subbituminous C in rank. The proximate and ultimate analyses of coal, the fusion temperature of the ash, and the oxide analysis of the ash shown in Table 3 are the averages of coal samples from 35 core holes drilled in the area of the proposed mine in the eastern part of the lease block. The number of samples taken to date in the western part of the lease block are insufficient to adequately characterize the quality of coal there but do indicate that Btu and sulfur content of the coal are slightly higher than in coal in the proposed mine area. The distribution of sulfur content, ash content, and Btu values in the proposed Rawhide mine area are shown respectively on Figures 5, 6, and 7. The actual range in sulfur content is 0.28 to 0.52 percent. The mining plan will be fitted to the natural distribution patterns of the sulfur, ash, and Btu so that coal will be produced which will consistently meet the Environmental Protection Agency's requirements and standards. Trace amounts of the toxic elements are significant in the evaluation of potential impact on the environment by coal burned in power plants. Results of analyses for selected trace elements in coal samples from five core holes drilled in the initial mining

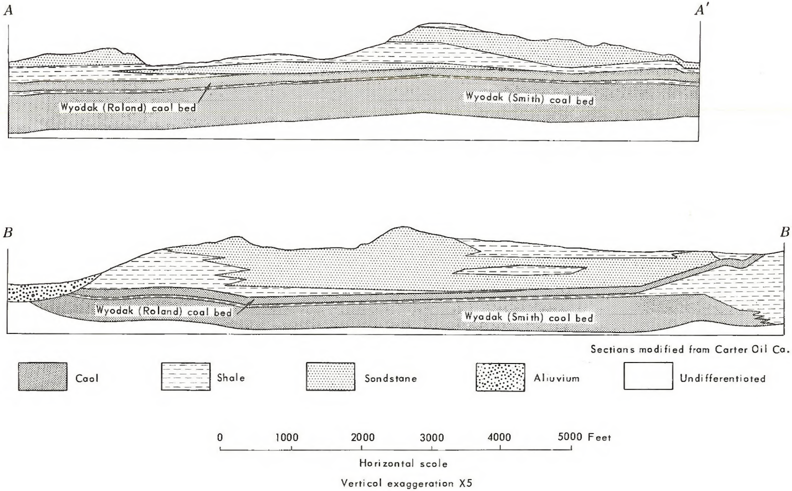
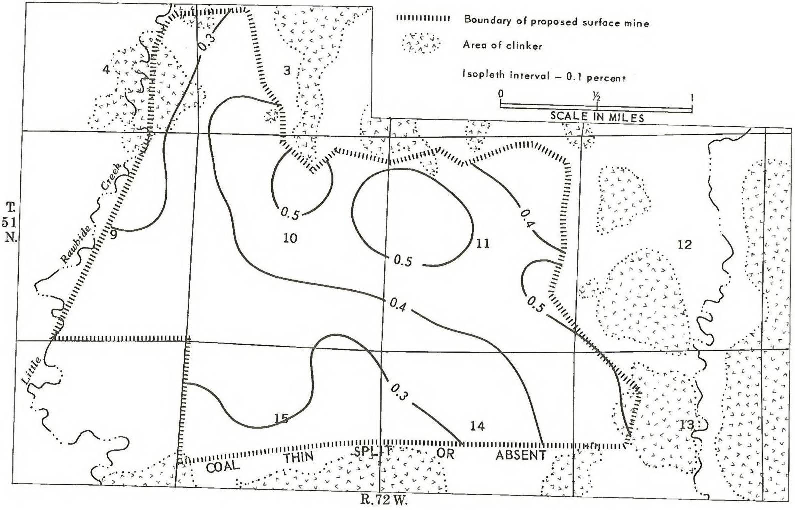


Figure 4

Sections Showing the Relationship of Coalbeds at the Proposed North Rawhide Mine, T51N, R72W, Carter Oil Company, Campbell County, Wyoming.

Figure 5

Sections Showing the Relationship of Coalbeds at the Proposed North Rawhide Mine, T51N, R72W, Carter Oil Company, Campbell County, Wyoming



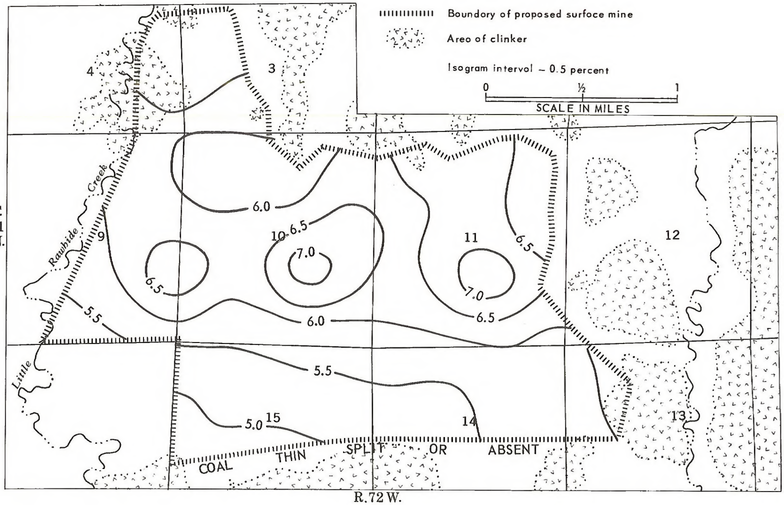
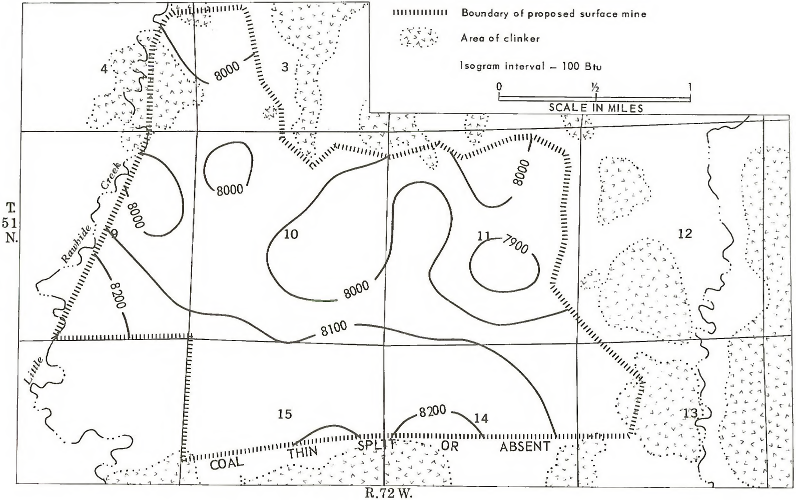


Figure 6

Distribution of the Ash Content of Coalbeds at the Proposed North Rawhide Mine, Carter Oil Company, Campbell County, Wyoming

Figure 7

Distribution of the Btu Content of Coalbeds at the Proposed North Rawhide Mine, Carter Oil Company, Campbell County, Wyoming



area are shown in Table 4. The concentrations appear to be normal for values as compared to other western coals.

Quantity of the coal

The general estimates of the amount of coal in the North Rawhide lease block are given in Table 5. Coal in the Wyodak bed within the lease area totals about 752.5 million tons; the basal three feet of the bed will not be mined and so has been excluded from the estimates. The mine block area contains about 393.5 million tons of coal of which about 354 million tons can be produced, assuming 90 percent recoverability of coal in the ground. About 76 percent of the coal in the mine block is contained in the lower (Smith) bed and 24 percent in the upper (Roland) bed. The estimated reserves appear to be adequate to meet the proposed schedule of production. The low stripping ratios of overburden per ton of coal shown in Table 5 make the coal amenable to surface mining.

Other minerals

Occurrences of minerals other than coal are not known on the lease block.

Clinker is abundantly distributed in the lease area and should be adequate to provide road metal and ballast (Figure 7, Chapter I and Figure 3, this chapter). Sand and gravel occur locally as lenses in alluvium on the intermittent streams.

Oil and gas

The Carter Oil Company's federal coal lease in T51 and 52N, R72W presently contains three plugged and abandoned oil and gas test holes. No other wells are known within the lease area; other oil and gas tests to any

Table 4

Analyses for Selected Trace Elements in Composite Samples of the Wyodak Coal in Drill Cores from the Proposed North Rawhide Mine, Campbell County, Wyoming (Value in Parts per Million. Spark Source Mass Spectographic Analyses by Commercial Testing and Engineering Company. Data supplied by the Carter Oil Company)

	Sample Number							
ELEMENT	NRH 58 1/	NRH 62 1/	NRH 76 1/	D-279 1/	D-281 2/	D-281 3/	D-286 2/	D-286 3/
Arsenic	1.8	<0.33	1.1	1.5	0.65	< 0.20	2.9	0.29
Boron	29.	3.6	32.	25.	2.8	3.2	25.	28.
Fluorine	200.	2.6	131.	170.	5.0	1.5	7.5	150.
Lead	1.9	0.51	0.93	1.6	0.54	0.41	1.6	0.54
Mercury	< 0.007	< 0.006	0.28	0.006	< 0.005	< 0.005	0.28	0.23
Selenium	0.18	0.06	0.14	0.15	0.10	0.04	0.31	0.06
Uranium	1.3	0.7	1.5	1.1	1.1	0.48	1.1	1.4
Vanadium	19.	8.3	13.5	16.0	13.0	5.8	13.	11.

1) Composite coal sample of upper (Roland) and lower (Smith) beds.

2 Composite coal sample of upper (Roland) bed.

3 Composite coal sample of lower (Smith) bed.

Table 5

Available Coal, in Thousands of Short Tons, in the Wyodak Bed at the North Rawhide Mine, Campbell County, Wyoming

Location	Lower (Smith) Bed[1] Acres	Lower (Smith) Bed[1] Coal in Place	Upper (Roland) Bed Acres	Upper (Roland) Bed Coal in Place	Total Coal in Place[2]	Recoverable Coal[3]	Stripping Ratio[4]
MINE BLOCK AREA							
T. 51 N., R. 72 W.							
Section 3	115	12,280	91	5,445	17,725	15,952	0.62
Section 4	29	3,388	29	1,443	4,831	4,348	0.50
Section 9	272	37,812	272	12,600	50,412	45,371	0.92
Section 10	570	75,214	535	28,707	103,921	93,529	1.34
Section 11	540	67,303	518	23,762	91,065	81,959	1.29
Section 12	20	1,115	0	0	1,115	1,004	0.97
Section 13	63	8,054	51	1,726	9,780	8,802	0.78
Section 14	240	40,627	240	8,974	49,601	44,640	0.78
Section 15	288	52,551	288	12,453	65,004	58,504	0.52
Sub-total	2,137	298,344	2,024	95,110	393,454	354,109	1.01[5]
REMAINDER OF LEASE AREA							
T. 51 N., R. 72 W.							
Section 4	361	34,822	343	21,485	56,307	50,676	1.14
Section 5	430	45,124	309	24,564	69,688	62,719	1.19
Section 6	449	50,376	597	36,493	86,869	78,182	1.46
Section 9	381	47,075	381	22,408	69,483	62,535	1.23
Section 14	0	0	121	4,590	4,590	4,131	2.29
Section 15	0	0	121	7,713	7,713	6,942	1.38
T. 52 N., R. 72 W.							
Section 31	81	9,607	81	7,167	16,774	15,096	1.36
Section 33	295	30,581	243	17,076	47,657	42,891	0.87
Sub-total	1,997	217,585	2,196	141,496	359,081	323,172	1.24[5]
GRAND TOTAL	4,134	515,929	4,220	236,606	752,535	677,281	1.12[5]

1/ Basal 3 feet of bed, which will not be mined, are excluded from estimates.
2/ Assuming 1,770 short tons of coal per acre foot.
3/ Assuming 90 percent recovery of coal in place.
4/ Cubic yards of overburden per ton of recoverable coal.
5/ Weighted average.

Source: Carter Oil Company

formation within the area could be applied for at any time. Data on the abandoned wells in the lease area follow:

1) During December 1955 through February 1956 a well was drilled and abandoned 662 feet from south line and 661 feet from west line (C SW 1/4 SW 1/4) sec. 4, T51N, R72W on public oil and gas lease W-012699; ground elevation is 4,285 feet; 10 3/4-inch surface casing was set at 930 feet; total depth is 9,840 feet in the Minnelusa Formation.

2) During October 1968 a well was drilled and abandoned 660 feet from north line and 3,437 feet from east line (on Lot 3 or NE 1/4 NW 1/4) sec. 6, T51N, R72W, on a private oil and gas lease; ground elevation is 4,208 feet; 9 5/8-inch surface casing was set at 834 feet; total depth is 8,376 feet in the Morrison Formation.

3) During December 1971 a well was drilled and abandoned 2,110 feet from north line and 1,840 feet from west line (SW 1/4 SE 1/4 NW 1/4) sec. 10, T51N, R72W, on public oil and gas lease W-18362; ground elevation is 4,336 feet; 8 5/8-inch surface casing was set at 339 feet; total depth is 8,000 feet in the Lower Cretaceous Skull Creek Shale.

Water Resources

Ground water

Formations exposed on the Carter coal lease, above the two coal seams to be mined, are the Wasatch Formation comprising the uplands of the area and the alluvium in the valley of Rawhide Creek. Thickness of alluvium at the Carter coal lease is not known but probably is 40 to 50 feet thick based on a thickness of as much as 60 feet about three miles downstream. Thickness and character of the alluvium were determined downstream by a line of test holes drilled in 1967 by the U.S. Geological Survey across the valley of Little Powder River below the junction of Rawhide Creek. Water level in the test holes augered was about 10 feet below land surface.

Movement of water in the alluvium is downstream as underflow. Movement of water in the Wasatch Formation that forms the coal overburden is northward in most of the lease area with a strong component toward Rawhide Creek in most of the lease area. In the eastern part of the lease area, water movement is northeast toward the valley of Little Powder River.

Surface water

The surface of the lease area is drained by tributaries of the Little Powder River. Two of these tributaries, Rawhide Creek and Little Rawhide Creek, originate outside the lease area and flow through it. Rawhide Creek is an intermittent stream that originates from the west and flows mainly in an easterly direction across the northern part of the leased area. About 4.5 miles of Rawhide Creek's channel lies within the leased area. The leased area also has about 35.3 miles of minor ephemeral tributaries, most of which drain into Rawhide Creek or Little Rawhide Creek.

The drainage pattern within the area is dendritic, indicating an absence of lithologic effects. Streamflow occurs mainly from runoff or rainfall. The major portion of annual runoff occurs as a result of convective storms. Long-time residents of the general area say that the highest flows occur when rain is preceded by hail which beats the grass cover and soil so there is less retention of runoff when the rain begins.

Rawhide Creek has a drainage area of 60.5 square miles upstream from its intersection with the lease boundary. Based upon its basin characteristics and channel geometry, it is estimated to have a mean annual flow of 2 cubic feet per second (cfs) (1,450 acre-feet per year) and a mean annual flood peak of 900 cfs.

Little Rawhide Creek has a drainage area of 29.4 square miles upstream from its intersection with the boundary of the lease area. Its mean annual flow is estimated to be one cfs (724 acre-feet per year) and its mean annual flood peak is 600 cfs.

Nearby gauged streams show there is a high variation in year-to-year runoff values; thus annual runoff and flood peaks can be expected to vary widely.

The average slopes of the streambeds of Rawhide Creek and Little Rawhide Creek are 15.6 feet per mile and 20.6 feet per mile, respectively. Minor tributaries have average slopes of as high as 250 feet per mile; however, there is very little head or downcutting of channels within the lease area. The streambeds are generally grassed and have a stable appearance.

The hydrologic characteristics of Rawhide Creek and Little Rawhide Creek have been significantly altered during the past five years due to the associated activities of oil-field developments in their basins. Numerous areas have been cleared and leveled for oil drilling activites.

The main use of surface waters in the area is for watering of domestic and wild animals. Some irrigation of hay meadows is done along downstream reaches of the Little Powder River.

Erosion and sedimentation

Erosion of the leased area appears to be low in relation to other parts of the Eastern Powder River Coal Basin due to better grass cover.

Water quality

Water samples taken from the Little Powder River near Weston and near the Wyoming-Montana state line had dissolved solids concentrations ranging from 17 to 55 parts per million. Sodium and sulfate were the major ions with lesser concentration of calcium, magnesium, and bicarbonate. These samples should be representative of water quality upstream in the lease area.

Vegetation

Vegetation on and adjacent to the Carter coal property is made up mostly of short grasses intermixed with big sagebrush. Plant communities on and surrounding the property are in an intermediate state of plant succession because of domestic livestock grazing for many years. With continued livestock grazing, little successional change would be expected.

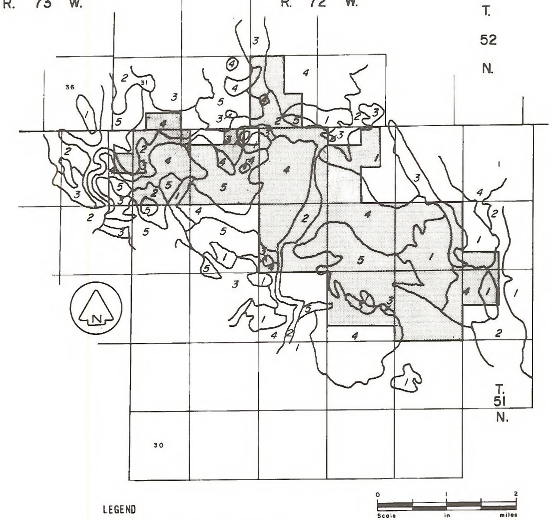
Plant communities have not been completely mapped for the entire area. (Vegetation is being mapped by the University of Wyoming for Carter, but is not yet complete.) In absence of a detailed vegetation map for the entire coal property, some broad vegetation communities have been delineated on Figure 8. These are described below and are keyed to Figure 8 with legend numbers.

Approximately 43 percent of the area (about 2,500 acres of a total of 5,800 acres) is occupied by a big sagebrush-western wheatgrass-blue grama community (Table 6) which is found on the steep rough broken areas throughout the property.

The second largest community is a big sagebrush-blue grama type (#5) and it occupies approximately 1,460 acres. This community is found on clay to loamy soils of gently rolling to rolling uplands.

A bluebunch wheatgrass community (#1) occupies about 900 acres within the area, and it is found on the shallow and stony soils of rolling to hilly scoria land. About 660 acres of an inland saltgrass-western wheatgrass community (#2) are found in the stream bottoms and swales on clay to loamy soils.

A few scattered areas of a big sagebrush-needleandthread-blue grama community (#3) make up about 280 acres on the rolling to gently rolling uplands with loamy to clay loam soils.



LEGEND

[1] Bluebunch Wheatgrass

[2] Inland Saltgrass-Western Wheatgrass

[3] Big Sagebrush/NeedleandThread-Blue Grama

[4] Big Sagebrush/Western Wheatgrass-Blue Grama

[5] Big Sagebrush/Blue Grama

Boundary of Carter Coal Property

Source: After Soils Data, USDA, SCS, Soil Survey of Campbell County, Wyoming, July, 1955, Soil Map Sheet No. 3 and 4.

Fig. 8
Vegetation Community Boundaries (Carter Coal Property)

Table 6

Some of the more common plants found on the Carter Mine Area:

Symbol	Common Name	Scientific Name
Agsm	western wheatgrass	Agropyron smithii
Agsp	bluebunch wheatgrass	Agropyron spicatum
Ansc	little bluestem	Andropogon scoparius
Bogr	blue grama	Bouteloua gracilis
Cafi	threadleaf sedge	Carex filifolia
Calo	prairie sand reedgrass	Calamovilfa longifolia
Dist	inland saltgrass	Distichlis stricta
Hoju	foxtail barley	Hordeum jubatum
JUNC	rushes	Juncus spp.
Kocr	prairie junegrass	Koeleria cristata
Orhy	Indian ricegrass	Oryzopsis hymenoides
Popr	Kentucky bluegrass	Poa pratensis
Pose	Sandberg bluegrass	Poa sandbergii
Stco	needleandthread	Stipa comata
ASTR	milkvetches	Astragalus spp.
LUPI	lupine	Lupinus spp.
LYGO	skeleton plant	Lygodesmia spp.
PHLO	phlox	Phlox spp.
PSOR	scurfpea	Psoralea spp.
Arca	silver sagebrush	Artemisia cana
Arfr	fringed sagewart	Artemisia frigida
Artr	big sagebrush	Artemisia tridentata
Oppo	plains prickly pear	Opuntia polyacantha
Save	greasewood	Sarcobatus vermiculatus

Vegetation on and adjacent to the property is considered to be in fair to good range condition for all communities. Estimated live vegetation ground cover (percent of ground covered with live vegetation) ranges from 10 to 35 percent. Such a sparse cover reflects the short growing season and semiarid climate which has an average annual precipitation of about 14 inches.

Aquatic vegetation in the area is not significant since there is limited water available. Two intermittent streams cross the property, Little Rawhide and Rawhide Creeks, and a small amount of aquatic and riparian vegetation exists in and along the shorelines of year-long pools or pockets of water.

Archeological and Paleontological Values

Dr. May's inventory report indicated prehistoric values exist in the area of the Carter lease (Morton May 1974). Water resources are usually indicators of probable human use. Moyers Springs, southeast of the lease area, is a prominent site and was used in historic times by Indians (Dr. May 1974). In the nearby area teepee rings are in good condition. Rawhide Creek and Little Powder River are excellent areas to look for Indian remains. Dr. May lists sites along the water courses and the ridges above the streams which fit a normal, logical pattern of use in prehistoric days. He also lists teepee ring sites, which he describes as minor and in poor condition. These teepee rings could be of great value because of their age. Man probably lived in this area many, many years ago. It is thought that today's resources existed eleven to twelve thousand years ago--water, game, and, in the area of the Carter lease, shelter. The Carter lease and the surrounding areas have been covered by air and water borne sediments for thousands of years. If man has been in the area for this long, evidence of his existence lies buried within the sediments.

The Paleo-Indian period extends back as much as twelve thousand years to the altithermal period--a time of dryness that followed the last glacial period. No information on what man was doing during the altithermal period is available.

Historical Values

A literature review and site examination was made of the Carter lease by a professional historian and resident of the Powder River Basin. Research indicates the westbound party of John Jacob Astor's American Fur Company, under the leadership of Wilson Price Hunt, crossed north of the Carter site in the summer of 1811.

Over the next few decades, trappers and traders became reasonably well acquainted with the region, but their major trails did not cross near the lease. These traders tended to concentrate their main operations within the territory of the more hospitable Crow Indians in the western part of the region.

This area was equally uninviting to surveyors, explorers, and immigrants interested in developing routes to the far west. Most of this historic activity passed well to the south and southwest.

No historic events have occured on the Carter site and no historic sites or structures were found there.

Aesthetics

The land form on the Carter lease is typical of the northern section of the study area; that is, it has sharper ridges, steeper slopes, and straighter, more narrow valley bottoms. The southeastern portion of the lease has a gently sloping valley bottom. This valley bottom is surrounded on the south, east, and north by several high, flat-topped cones. The central portion of the lease is fairly rough with steep gulleys, sharper ridges, and exposed soil. The extreme western edge of the lease is more gentle with irrigated farmland. Rawhide and Little Rawhide Creeks are wide meandering streams cutting through the lease block.

Texture on the lease area varies from a generally uniform texture of grass and sagebrush in the valley on the eastern edge of the lease to the more spotty, rugged textures of deeply incised gulleys in the central portion of the lease. In the western portion, textures are a combination of uniform sagebrush with well defined patterns of irrigated farmland.

Colors reflected in the area are generally soft, gray-green muted colors of sage and grass in combination with the gray-browns and yellow earth tones of eroded soils. The red clinker material prevalent in both the southern and extreme northern portions of the lease are absent throughout the middle and western sections of the Carter lease. Red scoria does show through on ridge tops and exposed slopes. Scale is well defined because of high, evenly spaced cones which extend to the south and east of the lease.

The proposed railroad spur follows gently rolling terrain except where it leaves the mainline. Here, the Donkey Creek valley has well defined bluffs and texture is a fairly even distribution of grass and sage. Color is soft gray-green of summer vegetation turning to light brown in the fall and winter.

Most of the lease area is presently undisturbed with only a few intrusions. A few roads traverse the area, and there are two small ranches with weathered outbuildings located in the northwestern portion of the lease. Outside the lease, particularly to the south and closer to Gillette, are cultivated fields. There is one abandoned oil site in the northeast half of the lease and a nearby soil blow out. There are two major highways that cross the lease--U.S. Highway 14 and 16 on the western edge and State Highway 59 on the eastern edge.

Compared to the Bighorn Mountains and the Black Hills, the quality of the scenery in the lease area is relatively poor. Relief provided by the cones, color of the clinker area, and roughness of the badlands give the lease some of the more scenic land north of Gillette.

Most of the lease area is hidden from view by the surrounding hills. Even where the two highways cross the area, the view of mining will be limited by topography. Only the railroad spur and loading silos will be exposed to view from Highway 59.

Wildlife and Fish

Big game

A more extensive description of the existing wildlife resources in the regional study area is found in Chapter IV, Part I. Aspects with broad applicability in the study area will generally be discussed in Chapter IV, Part I. Common and Latin names of vertebrate wildlife species known or suspected to occur in the Eastern Powder River Basin (and the lease area) are found in Tables 29 to 32, Appendix C.

Pronghorn antelope

Pronghorn antelope are the most common big game animals on this lease area which falls primarily in the Rozet Antelope Hunt area (19) established by the Wyoming Game and Fish Department. An average of six antelope per section or 50 antelope are supported by the lease area on a yearlong basis. About 100 acres of the area falls in crucial antelope winter range. Seasonal concentrations of antelope well in excess of six antelope per square mile may occur. An estimated 15 antelope are harvested here each year.

A sagebrush-rabbitbrush-forb combination is preferred habitat while skunkbush sumac also provides important antelope forage. Water is adequately available in the lease area with major sources being the Little Powder River and the Dry Fork of Rawhide Creek.

Mule deer

The lease area falls in the Wyoming Game and Fish Department's Campbell Deer Management Area (18) and supports an estimated average of three deer per section or about 30 animals on a yearly basis. The Campbell Management Area is considered to be an excellent deer producing area. The lease area proper is probably occupied at or near the habitat's capacity to support deer.

On the lease area sagebrush must be considered the staple food item. Skunkbush sumac is also important. Grasses are utilized primarily during the spring months at which time succulent new growth is attractive. Forbs reach their peak of deer use during the summer months, but new growth by shrubs also becomes significant. In the lease area lack of moisture sometimes reduces the summer value of shrubs and some grasses due to curing and low succulence. The usual transition by deer to shrubby vegetation occurs during the fall. Crucial winter range generally falls outside of the subject lands. For those who do winter in the lease area, restricted food availability intensifies the importance of shrubby species such as sagebrush, rabbitbrush and sumac.

Availability of cover may represent the most significant limiting factor to deer on the lease area. Where sagebrush range intermingles with rougher breaks and draws, quality cover requirements are met.

Other mammals

The presence of streamside habitats in addition to the rolling hillsides and draws complicates the mammalian picture in the area. Many species from adjacent life zones are involved and 42 species of mammals are known or suspected to occur in the area with the possiblity of nine species of bats being added at a later date (Carter Oil Company 1973a).

Predators

Representative species which may be in the lease area include coyote, bobcat, red fox, badger, and raccoon. Coyote, bobcat, and red fox inhabit the entire lease at least seasonally but are not abundant although the red fox may be increasing. The badger is a yearlong resident. Raccoons are closely tied to waterways providing reliable water and are found along the Little Powder River and Dry Fork of Rawhide Creek.

Rabbits and hares

The vast majority of cottontails present are the desert variety although the mountain cottontail may also be present. Cottontails are most numerous along drainage courses such as Rawhide and Little Rawhide Creek. Rocks, broken topography in association with shrubs, forbs, and grasses fulfill habitat requirements for food, water, and cover. Population densities of cottontails are an estimated 148 per square mile.

The white-tailed jackrabbit is cyclicly abundant while the black-tailed variety is far less common. Habitat requirements are met in open grasslands interspersed with shrubs. Estimated densities are 100 per square mile. Sport or commercial harvest of rabbits and hares is a minor impact at present.

Rodents

A variety of rodents occur on the lease area. Occurrence of the least chipmunk, thirteen-lined ground squirrel, northern pocket gopher, western harvest mouse, Wyoming pocket mouse, deer mouse, northern grasshopper mouse, and meadow vole has been confirmed. Ord's kangaroo rat, the porcupine, and bush-tailed wood rat can also be expected to occur here.

Results of small mammal trapping studies on the lease area indicate that there were greater abundance of individuals and variety of species trapped in the shrub-grass vegetative type as compared to the grassland type. Exceptions are that thirteen-lined ground squirrels and grasshopper mice were more abundant in the grassland type. A brief summary of results follows:

Catch per 100 Trap Nights

Species	Shrub-Grass Type	Grassland Type
Deer mice	6.2	1.0
Harvest mice	1.5	.5
13-lined ground squirrel	.5	.8
Grasshopper mice	.07	.35
Least chipmunk	.09	none
Pocket mice	.06	none
Others	.05	none

Furbearers

The badger, beaver, and muskrat are believed to occur on the lease area. Beaver and muskrat are directly dependent upon reliable water and riparian vegetation. Badger's prey consists primarily of ground squirrels, pocket gophers, prairie dogs, rabbits, and mice along with occasional insects, lizards, and grouse.

Upland game birds

Sage grouse

The dependency of sage grouse upon sagebrush in the lease area varies with the season, becoming most critical during the winter. Wintering birds tend to gather in large flocks and concentrate in sagebrush areas. An estimated five to eight grouse per section make seasonal or yearlong use of the lease area. Sport harvest is minimal. Specific strutting grounds have not been documented.

Sharp-tailed grouse

These grouse are found especially along Little Powder River, Rawhide Creek, and Little Rawhide Creek. Thickets, sagebrush land, and limited treed areas provide escape cover. Food items are varied but foliage, buds, seeds, and fruits comprise the bulk of the diet. Dancing (mating) grounds are not specifically documented although they surely exist.

Hungarian (gray) partridge

This exotic is reasonable well established in the lease area. Cover requirements involve the availability of brushy draws and semigrassland habitats. Small amounts of animal food used include insects and other invertebrates found on low vegetation in open places. The Hungarian feeds primarily on seeds which are readily available in the lease area.

Mourning dove

The dove is a wide-ranging seasonal resident primarily present during the spring, summer, and early fall months. They are a migratory species moving out of the lease area and Wyoming to winter in the southern states.

Waterfowl and shorebirds

Waterfowl and shorebird habitat is limited to previously mentioned streams and numerous area stockwater ponds. The major value of this habitat results from the nesting, resting, and feeding opportunities provided. Most common species include the mallard, gadwall, and green-wing teal ducks, eared grebe, Wilson's phalarope, American avocet, killdeer, and mountain plover. Other probable species are listed in Appendix C.

Other birds

Raptors

The most common raptors on this lease area are the red-tailed hawk, Swainson's hawk, rough-legged hawk, and the American Kestrel. All of these species nest on or near the lease area and do at least part of their foraging there. During winter months, significant numbers of rough-legged hawks, bald eagles, and golden eagles move into the general area from the north where winters are more severe. Other raptors occurring include the ferruginous hawk, marsh hawk, prairie falcon, great-horned owl, and short-eared owl.

These raptors prey primarily on various rodents, cottontails, and jackrabbits. Small birds are occasionally taken. Significant numbers of grasshoppers and other large insects are readily utilized by raptors during periods of availability.

Song birds

The number of species of song birds present on this lease area at various times of the year may exceed 100. Most common species are the western meadowlark, lark bunting, and the horned lark. Common nighthawks, black-billed magpies, and red-winged blackbirds have been observed on the lease area as well. Food and nesting habits, territorial behavior, and vegetative characteristics vary enough that a considerable diversity of birds in this group can utilize the lease area.

Fish

Fish habitat within the lease area is limited to a few deep pools which retain water throughout the year such as in the otherwise intermittent flows of portions of Little Powder River and Dry Fork of Rawhide Creek. From 13 to 15 species, including rough fish, may be found in ponds and streams of

the lease area (Carter Oil Co. 1973a, p.9). Species include goldeye, western white suckers, mountain suckers, northern redhorse, plains flathead chubs, sturgeon chubs, plains longnose dace, brassy minnows, northern plains minnows, northern flathead minnows, channel catfish, northern bullheads, and stonecats.

Reptiles and amphibians

Thirteen species of reptiles and six species of amphibians have been recorded on the lease area (Carter Oil Co. 1973a, p.8). Populations are sparse. Included are turtles, lizards, snakes, frogs, toads, and salamanders. Examples are the eastern short-horned lizard, plains hognose snake, prairie rattlesnake, pale milk snake, leopard frog, plains spadefoot toad, Great Plains toad, and the tiger salamander. Amphibians are tied to aquatic environments for at least portions of their life cycles.

Invertebrates

Information concerning invertebrate populations found on this lease area is sparse. Common insect groups include an abuundance of grasshoppers, beetles, ants, wasps, bees, butterflies, and moths. A variety of spiders is also present. These groups and others present include plant eaters, scavengers, parasites, and predators. Many species of plants depend on insects for pollination.

Threatened species

Black-footed ferret

While this rare mammal has not been sighted on this lease area, its presence is possible. Ferrets have been reported in the Powder River Basin in recent years. No prairie dog colonies, principal habitat of ferrets, were discovered during a field examination of this lease area. Where prairie dogs or

other small mammals are known or suspected to occur in numbers, the possible presence of the black-footed ferret cannot be discounted.

Peregrine falcon

The extremely rare peregrine falcon is believed to occur in the lease area during periods of migration.

Prairie falcon

The prairie falcon, not in the USDI "Red Book," is nevertheless rare in Wyoming and known to exist in the Powder River Basin. The periodic presence of this falcon in the lease area is highly likely.

Recreation

The primary recreational value of the Carter lease is for hunting mule deer and antelope. Good habitat exists because of the sheltering nature of the ridges and trees on the northern edge of the block, cultivated lands, and some perennial pools along Little Powder River and Rawhide Creek.

An average (1971, 72, 73) 2,562 antelope hunter days and 6,190 deer hunter days were annually recorded within the management units northwest and northeast of Gillette which cover the Carter lease. (Wyoming Game and Fish Commission 1971-73). However, less than one percent of the management areas listed here are occupied by the Carter lease with rather insignificant annual hunter days (100) expected on the lease.

Upland game and small game could also be hunted on the lease; however, there are no recorded spot hunting records. No outstanding or unusual off-road vehicle use was observed on the Carter lease. Some off-road vehicle use does occur; however, much of this can be attributed to hunting or driving for pleasure.

Local groups contacted indicate no significant concentrations of collectable gemstones. Some petrified wood is known to exist on the lease site. Some artifact collecting may occur, but it is not considered a legitimate recreation resource use. Petrified wood and dried vegetation may be found on the lease, attracting some collecting.

Some perennial pools along intermittent stream beds support non-recreational fish. Without some larger impoundment, this lease would not be fished.

Some minor erosional features on sandstone caprock and red clinker heads provide interesting contrasting colors at different periods of the day.

These may be seen from State Highway 59. The maximum relief, however, is no more than 200 feet from valley floor to the crest of ridges.

Frequent opportunities to view antelope exist both from on and off State Highway 59, a situation common to the region. No rare or endangered species or wild horses are known to be indigenous to the site, but with rock outcrops, trees, and ridges, there are some opportunities to view birds of prey and other wildlife.

Agriculture

Livestock

Five ranching operations currently make use of the surface resources included in the Carter Oil Company North Rawhide Unit coal lease. The ranching uses include livestock grazing and associated cropping. Of the 5,800 acres included in the Carter unit, 5,760 acres were owned by six private individuals and 40 acres are federally owned and are administered by the Bureau of Land Management. Carter Oil has purchased the lands of four of the private owners to be most affected by the mining and is negotiating surface arrangements with the other private surface owners. The purchased lands have been leased back to the former owners and/or operators for ranching use until mining operations commence.

Ranch operation A

The Carter coal lease underlies approximately 80 acres of the ranch that is west of State Highway 16-18. This is native range land and makes up less than one percent of a large ranch. The Missouri River Basin Range Survey rates the carrying capacity at two acres per animal unit month (AUM) which indicates a highly productive site. No range improvements, other than the highway right-of-way fence, are located on the site. Rawhide Creek traverses the northern half of this acreage and does furnish livestock water during part of the year.

Ranch operation B

The Carter coal lease underlies about 360 acres of this ranch that is based mainly east of Wyoming Highway 59. This land is rated at a carrying capacity of four acres per AUM by the Missouri River Basin Range Survey and

makes up about six percent of this operation. The only range improvement on this land is the highway right-of-way fence. No sources of water are located on this land but the Dry Fork of the Little Powder River and a well are located one-half mile east in the same pasture.

Ranch operation C

This total operation is based on 6,260 acres of range and cropland; 1,120 acres are included in the Carter lease: 1,080 acres of range and 40 acres of cropland. The rangeland is used to summer 70 cows and calves out of a herd of 170 cows. The rangeland is rated at approximately four acres per AUM. The highway right-of-way fence and two division fences are used for livestock management. A water well on the coal lease area furnishes water for one pasture and is the only source. The 40 acres of cropland are alternately summer fallowed and cropped. Barley yields approximately 50 bushels per acre and wheat yields about 35 bushels per acre. Some of the grain is pelleted and used to supplement winter feed.

Ranch operation D

This entire ranch operation contains 3,040 acres: 2,000 acres of summer range and 1,040 of winter range and cropland. The summer range is located about five miles northwest of the Carter coal lease. Of the 1,040 acres in the Carter lease area, 800 acres are over the coal lease, and of that amount, approximately 250 acres are cropped. The rancher runs primarily a yearling operation. About 75 calves are bought between October and March and are kept until they are two years old and sold as grass-fat steers. The operation supports 150 steers and some sheep. Four hundred sheep are wintered in partnership with a neighboring ranch operation. This ranch provides about 30 percent of the range, or enough to winter about 120 sheep.

The ranching operation also produces a cash crop of barley or wheat from 250 acres of cropland. The wheat yields about 50 bushels per acres and the barley, 35 bushels per acre.

Little Rawhide Creek runs along the southeastern edge of this property, and there is a good water well located at headquarters. There is also another water well located in approximately the center of the property. This unit is fenced more or less on the ownership boundary.

Ranch operation E

This operation is made up of 6,000 acres of deeded land and 4,000 acres of leased lands. The Carter lease is under 3,280 acres of the deeded land and 240 acres of the leased land. This ranch is operated in conjunction with another ranch located south of Gillette and is used primarily for winter range. The native range land is rated at a carrying capacity average of four acres per animal unit month by the Missouri River Basin Range Survey.

Approximately 1,100 heifers and yearling steers are wintered on this ranch. Four hundred sheep are also run on this ranch unit in conjunction with a neighboring ranch. This ranch provides 70 percent or wintering range for 280 head. Of this ranch operation, 35.2 percent is over the Carter lease.

About 400 acres of land are share cropped. All the grain is sold and none is retained for use for livestock supplemental feed. Several small hay meadows provide hay during critical winter periods. Hay production is limited, averaging less than one ton per acre. About 65 acres of the hayland and none of the cropland is over the Carter lease.

Rawhide Creek and Little Rawhide Creek are intermittent streams on the land and are both on and off the lease area. The one known well is located at the headquarters on the coal lease.

Farming

Farming operations on the area included in the Carter Oil Company North Rawhide Unit coal lease are not of major significance. The area is generally not known for its farming due to low rainfall.

Of the five farming-ranching operations involved in the Carter lease area, three have some acreage involved that is used for farming. Of the 5,800 acres in the lease area less than three percent (approximately 160 acres) is used for farming.

Small grain yields are economical if summer fallow and cropping are rotated. Barley yields about 50 bushels per acre and wheat yields 35 bushels per acre. Since there are no reliable sources of stream water for irrigation, all of the crops are nonirrigated. The hay crop yield is approximately one ton per acre.

Of the 710 acres of farm land enumerated by three operators, 22.5 percent, or 160 acres, is on land included in the Carter coal lease.

Transportation Networks

The site of the Carter coal lease is located approximately six miles north of Gillette and overlaps both U.S. Highway 14 and 16 and State Highway 59. Both of these routes are lightly used, individually carrying less than 800 vehicles per day. (Wyoming State Highway Commission 1972). Most of this traffic is due to daily commuting by workers in the oil fields north of Gillette.

There are approximately six unimproved and graded dirt roads across the lease area that provide access to ranches and other operations. These roads, if maintained, are done so privately. Traffic flow figures on these roads are not available, but it can accurately be described as extremely light. No known county maintained roads lie within the lease area.

The lease boundaries include within them two of the pipelines shown on Figure 82, Chapter IV, Part I. Major electric transmission lines in the area are shown on Figure 83, Chapter IV, Part I.

The proposed railroad spur runs approximately 12 miles from the east end of the Carter lease area in a southeasterly direction tieing into the existing Burlington Northern line approximately nine miles east of Gillette. This route crosses 8 to 10 unimproved or graded dirt roads at least two of which are county maintained. All receive a very light amount of traffic. At least one pipeline right-of-way will be crossed.

Socio-Economic Conditions

Employment

Total employment within Campbell County increased by 111 percent (2,526 jobs) during the 1960 to 1970 interval (Table 46, Appendix C). This increase resulted from significant employment increases to the sectors of petrochemicals (1,140 jobs) and other residentiaries (1,236 jobs) of 509 percent and 110 percent respectively. This is a direct result of the oil boom which occurred within Campbell County in the 1960's. Petrochemicals and agriculture are the top two employment sectors within the county. Coal mining, power generation, and railroad sectors combined comprise only 1.7 percent of total county employment. Presumably as a secondary result of the 1960's oil boom, the other manufacturing sectors (manufacturing not related to energy mining or fuels) experienced a large percentage growth of 628 percent but still remains a moderately low numerical employer (131) in the county. The rate, of unemployment 2.6 percent, is low.

Income

The median ($11,303) and mean ($12,949) incomes of Campbell County are the highest in the eight-county region. The introduction of oil and coal development with associated high incomes have contributed to the generally high income levels. While 60.6 percent of a total of 3,085 families had incomes which exceeded $10,000 in 1970, 26.2 percent of the families had incomes greater than $15,000, and 10.2 percent of total families had incomes less than $5,000. This percentage of families with less than $5,000 is nearly 50 percent less than the study area and state averages.

Other existing socio-economic conditions (population, housing, education, etc.) are in Chapter IV, Part I.

CHAPTER III

PROBABLE IMPACTS OF PROPOSED ACTION

Development of the Carter mine property will impact various environmental components. Carter has control of 5,800 acres of subsurface coal, including 80 of private coal. An estimated 80 percent of the total area (4,640 acres) will be mined. Plant facilities, occupying approximately 100 acres, will be located on the lease area but outside the area to be mined. The impact analysis covers the 4,740 acres to be disturbed on the mine property. An estimated 636.8 million tons of coal will be mined over the life of the mine (57 years - 2033). The impacts occurring in this time span have been analyzed to the extent possible.

Construction of a 12-mile railroad spur (including loading loop) and 9 miles of powerline and relocation of 2 miles of highway will be required. To the extent that information as to location was available, the impact of these actions was analyzed.

For purposes of this analysis, it is assumed that all coal mined will be exported via railroad. Carter Oil has indicated tentative plans to locate a gasification plant within the area sometime in the future. At such time a federal action is required, an impact statement will be prepared on construction and operation of this plant. This analysis did not consider possible construction.

The impact of transportation of the coal off the spur rail line is covered in Part I of this statement. The impact of the offsite use of the exported coal is beyond the scope of this statement. The impacts analyzed

pertain only to this mining operation. Cumulative regional impacts are analyzed in Part I.

Air Quality

Mining an estimated 636.8 million tons of coal on 4,640 acres (of a total coal property of 5,800 acres) will create an impact on air quality for the expected life of the mine, an estimated 57 years up to the year 2033. Mining is expected to begin in 1976 (one million tons) which will result in disturbance of 60 acres for the initial boxcut and spoils areas. Production per year will increase up to 12 million tons per year in 1983, and then it is assumed that it will level off for the remainder of the mine life. At the 12-million-ton production level, an estimated 88 surface acres and 16.1 million cubic yards of overburden will be disturbed per year. Over the life of the mine, an estimated 828 million cubic yards of overburden will be removed and handled. Removal of vegetation and disturbance of topsoil and overburden will expose fine-grained soil and parent material to wind action which is frequently quite strong. Soil particles will be lifted by the wind and carried into the atmosphere, causing a reduction in air quality and reducing visibility during periods of high wind. Coal dust from crushers, trucks, coal piles, and loading operations will also pollute the air during windy periods.

Construction of a 12-mile railroad spur, including loading loop, to the mine site will disturb additional acreages, creating dust and wind-blown particulate matter. Spur railroad construction will involve soil disturbance on 252 acres. Plant construction will disturb 100 acres, causing dust conditions.

Emissions from machinery, vehicles, and trains will add particulate matter and odor to the air on and adjacent to the mine site. Emissions as a result of train operations over this spur line are shown in Table 1.

Table 1

Train Emissions Resulting from Transporting
Carter Coal Production

Year	Trains Per Year	Million Tons/Year	Fuel/Day 1,000 gals.	Emissions - Tons Per Year Particulates	SO_2	NO_x	CO	HC
1980	455*	5	1.0***	4	10	67	24	16
1985	1,091**	12	2.5	11	26	167	59	42

*455 loaded - 455 unloaded
**1,091 loaded - 1,091 unloaded
***Uses one-sixth as much fuel as that required for regional (40 minutes on spur track versus 4.3 hours on new railroad)

SO_2 - Sulfur dioxide
NO_x - Nitrogen oxides
CO - Carbon monoxide
HC - Hydrocarbons

Increased population (2,100 by 1990) associated with the mine, its employees, and secondary employment will generate increased vehicle traffic, adding additional emissions to the air and causing a further decrease in air quality. The cumulative impacts of this type of increase of emissions are discussed in Part I of this statement.

With increased mining and coalbeds opened to the atmosphere, the chance of accidental coal fires will be increased. These will add particulate matter and other potential toxic emissions to the atmosphere. The emissions will be similar to those from a coal-fired power plant without any emission controls. Increased train traffic and people on the area also increase the possibility of wildfire occurrences. These would add to a temporary lowering of air quality with the addition of smoke and particles to the air.

During inversions, which could occur as many times as 15 2-day periods per year, emissions, dust, and coal dust could be detrimental to the health of people and vegetation on site. When inversion periods occur, Gillette (9 miles south of the lease) could be affected. During inversion periods, respiratory conditions could be aggravated, asthmatics irritated, and lung disease caused or worsened. During normal weather conditions, these pollutants will be carried downwind (to the east and southeast), dispersed, and diluted before reaching any population centers. However, during periods of north winds which occur an estimated 30 percent of the time, these pollutants could be carried into Gillette.

Reduction in air quality is projected to begin in 1975, rise to a maximum in 1983, and then level off thereafter until the end of the mine life in year 2033.

Topography

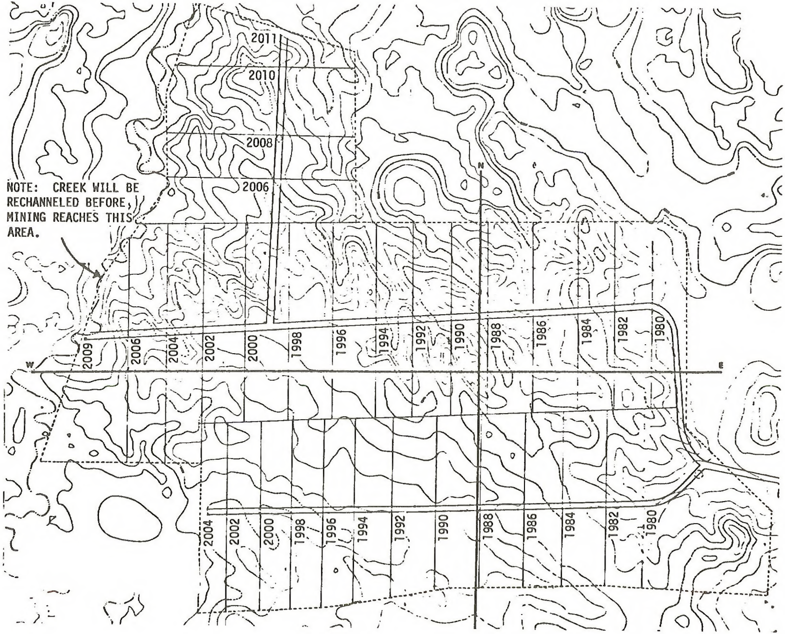
Factors that make mining economically feasible in the coal basin (thin overburden and thick coal) also cause local topographic change. Removal of thick coalbeds with little overburden for backfill creates a discrepancy between the volume of coal removed and the spoils returned to the mined area. Coalbed thicknesses in the mining area range from 50 feet to about 120 feet. Overburden thickness ranges from a few feet to 240 feet. The decrease in altitude over the lease area will range from a maximum of 105 feet to a minimum of a few feet. The removal of 82 feet of coal and return of 100 feet of broken spoil lowers the land surface about 62 feet. The maximum decrease in altitude will occur in the areas which have thick coal in relation to thin overburden.

The topography at the North Rawhide mine before mining is shown in Figure 1. The mining proceeds westward from the burnline. The topographic slope can be increased or decreased. The smoothing and rounding of the spoil piles generally tend to create a more subdued, rolling topographic relief. Any cliff-like or abrupt topographic breaks now present on the area will be eliminated.

In analyzing the impact of mining coal that averages 82 feet thick, based on 90 percent recovery, the following assumptions were made: mining proceeded east to west, overburden was expanded by 20 percent, and spoil was smoothed along each panel. Relief is reduced by smoothing the spoil. The spoil is smoothed in such a way as to eliminate impounding surface water. The landscape has not been reshaped to conform to the original configuration of the surface.

Figure 1

Topography of the North Rawhide Mine Before Mining. Contour Interval 25 Feet.



The well-defined drainage on the eastern side of Little Rawhide Creek can be smoothed as in the model (Figure 2). Little Rawhide Creek and its tributaries will have their channels diverted and altered. The new creek channel may appear considerably flatter and straighter upon completion of mining.

At completion of mining, remains of the highwall will be visible on the north side of the mined area. The highwalls illustrated have not been reduced but can easily be drained into Little Rawhide Creek. These mine pits will create a long, narrow, trough-like depression and will probably be the most visible indication that the topography of the area has been altered (Figure 2).

Topographic impacts will occur slowly and may be noticeable in a small portion of the mined area at any one time. Initially, the mining-reclamation model, including areas stripped, mined, rough and smoothed spoils and reseeded area, will cover about 100 acres. This area will increase to about 500 acres at the full annual rate of 12 million tons of coal. Until completion of mining, the most severe impact will be that of the highwall or active working mine face.

Figure 2

Estimated Topography of the North Rawhide Mine After Mining Thick Coal Beds. Contour Interval 25 Feet.

Soils

Mining of the area will result in the destruction and mixing of the topsoil on 4,640 acres of the 5,800-acre mining area. This will destroy all of the soil characteristics, properties, micro-organisms, and climatic relationships which have been established over a long, geologic time span. Approximately 1,300 acres of medium to highly productive, agricultural soils comprised of the Terry (600 acres), Ulm (500 acres), Satanta (120 acres), and other (80 acres) soil types will be destroyed. The productivity of the remaining 3,340 acres would be impacted slightly because they are not suitable for agriculture and are low in vegetative productivity.

In addition to the topsoil acreage which will be disturbed, approximately 828 million cubic yards of overburden or lower soil horizons will be removed and disturbed during the life of the mine. This will result in complete destruction of all soil horizons, parent material, and soil characteristics. It could result in bringing elements such as boron to the surface which may be toxic to plant growth. At completion of mining operations, the soil structure will be completely different from what exists today and productivity could be destroyed.

These disturbances will result in fine-grained soil and parent material being exposed to wind and water actions. Soil permeability and infiltration rates will be reduced, increasing runoff, soil erosion, and sedimentation. Wind action, which is almost constant over the area, will cause fine soil, silt, and clay particles to be lifted into the atmosphere, reducing air quality and adding to soil loss.

Alteration of Rawhide and Little Rawhide drainage patterns in the area will impact the Little Powder River downstream and adjoining land areas. Streamflow will be altered, increasing velocity and causing increased soil erosion and sedimentation along the streambanks and downstream. Some areas may be deprived of soil moisture, thereby affecting soil productivity and vegetative growth.

Construction of mine facilities will disturb and permanently remove from productivity an estimated 100 acres of soil. Road and powerline construction and highway relocation will disturb an additional 249 acres of soil, destroying topsoil characteristics and increasing erosion and loss of soil particles to wind action.

In addition to losses and disturbances associated with mining activities, construction of a 12-mile spur rail line to serve the mine will disturb 252 acres of soil. Topsoil along the entire route will be mixed and disturbed, destroying all of its present micro-organisms and relationships. An estimated 116 acres will be permanently lost to productivity within the right-of-way to track, ballast slopes, etc.

Additional offsite soil impacts will result from increased population resulting from mining operations. Approximately 105 acres will be affected and removed from production by 1990, and increased recreation use, particularly increase in off-road vehicle use resulting from this population increase, will create additional soil impacts such as compaction, erosion, and sedimentation.

Equipment necessary for mine operations and spur rail line construction crossing undisturbed soil areas susceptible to compaction will impact soil permeability and water infiltration rates. This will increase runoff, erosion, and sedimentation.

During the life of the mine (until 2033) approximately 4,740 acres of soil will have been disturbed on the mine property and 100 acres permanently removed for mine facilities (office, silos, maintenance shops). In analyzing the isopach maps (overburden thickness) a permanent loss of 500 acres to inundation by a lake which will be created by ground water seepage after mining is completed has been projected. Sufficient overburden will not be available for complete reclamation.

An estimated 606 acres will be disturbed offsite for powerlines, spur rail line, roads, and population increases. Two hundred forty-five acres (40 percent) of this will be permanently lost to railroad beds, roads, and housing.

Mineral Resources

The most important impact is the one on coal. The removal and consumption of an estimated 636.8 million tons of coal from this area over the expected 57-year life of the mine will result in depletion of a non-renewable energy source. The coal produced from this area will be exported to utility plants in the midwest for production of electrical energy.

Some coal will be lost from production in the mining process, mostly by leaving fenders of coal to block spoil piles from working faces. This loss of coal is temporary, and the subsequent impact minor as these fenders can be recovered before the pit is abandoned to spoils and waste.

Water Resources

Ground water

During mining and reclamation

Mining of a total of 636.8 million tons of coal over the life of the project (57 years - 2033) and removal of 828 million cubic yards of overburden will destroy aquifers located within the area. Disruption of aquifers would cause a cessation of flow and a draining of water into the pit. Pumping for dewatering during mining operations and for consumptive use will lower water levels to the base of the coal in the pit. The cone of depression from the point or points of pumping will extend outward to an estimated four to eight miles. At the outer edge of the cone of depression, water levels will be lowered insignificantly. Within the area of influence caused by pumping, water levels will be lowered at increasingly greater depths toward the mine area. Water wells and springs that derive water from shallow aquifers within the area of greater depression may also dry up. Where the aquifer is discharging into a stream, total flow could also be reduced. Reduction in water levels could impact agricultural use and wildlife populations.

No significant flow can be expected to occur between aquifers as a result of mining coal. Reduced overburden could cause a slight increase in upward movement in the mine area with consequent small increase into the mine pit.

Recharge occurs in higher interstream areas with movement away from topographic highs and toward lower stream drainages. As mining progresses, recharge in interstream areas could be reduced in backfill which will be less permeable than undisturbed premining deposits. Discharge of water from aquifers at the mine sites near stream drainages could be increased slightly because of

decreased load with a consequent upward increase in potentiometric pressure in the underlying artesian aquifers.

After reclamation

Aquifers affected will be local, restricted mostly to the mining area where coal was removed and overburden disarranged by removal and replacement as backfill. Topography will be subdued from its original contour, thus runoff will be reduced, leaving more time for infiltration of water downward toward the zone of saturation. However, the disturbed backfill will not be conducive to the downward percolation of precipitation. Thus, the probability of greater, or less, recharge is speculative at the mine site backfill. Most recharge to the aquifer systems is in the higher interstream areas and, thus, will not be affected by mining operations.

Surface water

Mining activities will destroy existing drainage patterns in parts of the area. The channels of Rawhide and Little Rawhide Creeks will have to be diverted around the mine pit to carry its natural flow. This channelizing may decrease annual and low flows due to seepage loss to the pit. Peak flow will not be significantly affected unless protecting dikes breach and the flow is diverted to the pit. Characteristics of the minor tributaries will be interrupted by mining until reclamation is complete.

Channelizing stream courses may cause increased flow velocities, resulting in accelerated erosion of streambeds and banks. In changing the course of the stream, its base level may be lowered, resulting in headcutting of tributaries. Release of production waters, including mine drainage, would alter flow characteristics, possibly resulting in accelerated erosion of

streambeds and banks. Depending on the amount of release, increased erosion and sedimentation could extend several miles down the Little Powder River.

Water quality

Ground water

As the mined area is a point of discharge, reduction of quality of water in aquifers will not occur while mining is taking place. After spoils have been returned to the pit, leaching could occur which may reduce the chemical quality of water in the aquifers. Leaching of mineral constituents and possible toxic trace elements will occur where water infiltrates through the backfill. In time, this ground water will be discharged at some place either as seeps or springs along drainages or as ground water discharge into Rawhide Creek. As water moves from recharge to points of discharge, recharge from additional infiltration through undisturbed rocks will dilute the higher mineralized water so that the increase in mineralization of water at discharge areas could be insignificant.

Surface water

Erosion and sedimentation will be increased during construction and operation of the mine as vegetation is removed. High sediment yields will occur from spoil piles until they have been reclaimed and a protective grass cover established. Increased erosion and sedimentation could lead to a lowering of water quality in the streams.

Dissolved solids load in water downstream from the proposed mining site will increase during mining and reclamation, but changes in dissolved solids concentration will depend on the amount and concentration of water in receiving streams. Dissolved solids concentration in runoff from newly

exposed surfaces will increase. Continuance of increased dissolved solids loading in downstream waters after reclamation is completed will depend on the degree of success achieved in the reclamation effort to protect exposed surfaces from leaching and erosion.

Increased population associated with mine development could affect water quality through recreational use of the area and from adding additional untreated sewage to water in the area.

Vegetation

During the 57-year life of the mine, vegetation will be destroyed on 4,740 acres (4,640 mined - 100 plant facilities). Vegetation will be removed progressively as mining proceeds across the leased area. Vegetation affected during this period is shown in Table 2.

Table 2

Vegetation Types and Amount to be Disturbed

Vegetative Type	Acres
Big sagebrush/western wheatgrass-blue grama	2,038
Big sagebrush/blue grama	1,185
Bluebunch wheatgrass	758
Inland saltgrass-western wheatgrass	522
Big sagebrush/needleandthread-blue grama	237
Total	4,740

With initiation of coal production in 1976, some 60 acres of vegetation will be lost from the initial pit (boxcut), in initial topsoil storage areas, and in spoil waste areas. Damage will be about equally split between bluebunch wheatgrass and big sagebrush/western wheatgrass-blue grama communities. This will accelerate up to 88 acres in 1983 when mining increases to 12 million tons per year. It is assumed that vegetative destruction per year will remain constant (88 acres per year) from that point until the end of mining in 2033.

Construction of mine facilities and spur rail line will destroy an estimated 352 acres of vegetation, 61 percent (216 acres) permanently. Relocation of Highway 59 and construction of a powerline into the mine site will temporarily destroy another 249 acres of vegetation. Vegetation communities affected (about

equally) include bluebunch wheatgrass, big sagebrush/needleandthread-blue grama, big sagebrush/western wheatgrass-blue grama, and big sagebrush/blue grama.

An estimated 500 acres or about 10 percent of the total vegetative area within the property will be lost permanently because of the lack of fill to completely reclaim the mined area. Population increase associated with development of the mine will permanently remove another 105 acres of vegetation by 1990. Increased recreation use originating from this population will cause additional impact on vegetation within and outside of the mining property.

Haul road dust and fugitive coal dust from coal mining, blasting, transporting, processing, and loading on unit trains will be deposited on vegetation adjacent to the mine. Toxic chemicals in the deposited dust may damage vegetation when wetted by dew and light rain. Dust-covered and damaged vegetation would be less palatable and possibly toxic to livestock and wildlife.

The use of herbicides for maintenance of powerline and rail spur rights-of-way would cause mortality of target species as well as short-term damage to nontarget species. These areas consist of 343 acres in the bluebunch wheatgrass, big sagebrush/needleandthread-blue grama, and big sagebrush/blue grama communities. Drift off the target area could result in additional vegetative damage.

Suitable vegetation may be difficult or impossible to reestablish on some of the mined area. Toxic or nonproductive material may be brought to the surface. Microclimate will be changed. Soil structure will be destroyed with loss of some topsoil. These effects of mining may individually or in combination make revegetation difficult or impossible in some areas. With the type of climate and existing soil types in the area, prediction of reclamation

success is sketchy. However, an assumed reclamation success in this area is explained in Chapter III, Part I, Reclamation of Mined Lands.

Young vegetation from reclamation will attract wildlife which like to graze on new, young shoots. This grazing will inhibit early growth and revegetation of the disturbed areas.

Archeological and Paleontological Values

Archeological surveys are being conducted by the University of Wyoming on the Carter lease. The survey and report have not been completed indicating the existence of sites. However, there is surface evidence and the possibility of sites.

With the unknown archeological-paleontological values, there could be significant impacts from strip mining. There will be 4,640 acres involved in strip mining on this lease. Approximately 828 million cubic yards of overburden will be moved to mine the coal. Additional area (240 acres) will be occupied by facilities such as crushers, silos, railroad spurs, roads, offices, and equipment-maintenance buildings. Moving overburden or establishing permanent structures will either destroy potential archeological sites or make them unavailable for study and salvage.

Besides the direct impact of mining, there will be some indirect impacts associated with the population increase expected to be generated by construction and operation of the mine. Increased population will permanently remove and disturb additional acreage (105 acres by 1990) which could possibly contain archeological values.

Recreational use associated with this population will impact known as well as unknown archeological sites throughout the study area. Arrowhead hunters, rock collectors, pot hunters, and off-road vehicle users will all disturb additional surface acreage, destroying evidence which could provide information on archeological sites.

Historical Values

No historical values will be impacted by this action.

Aesthetics

Mine operations will impact the elements of form, line, color, and texture which combine to make up the resource termed aesthetics. Disturbance of vegetation, removal of overburden, and creation of new landforms cause a change in the appearance of the landscape.

Contrasts in color will be created by stripping away the vegetative cover and overturning the soil material. The predominant color tones now seen on the area are light browns and grays. Mining will create colors of yellows and light grays which will differ from the color of the surrounding area, creating contrasts.

Texture as created by vegetative patterns and degree of erosion will be changed. Smoothing of spoil piles and reclamation with grasses will create a smoother and softer texture. The new texture created on the lease area will contrast with the roughened and broken texture present on the surrounding areas. The change in texture will result in less variety and natural configuration in the landscape. It will create monotonous scenery, at least on the area that is mined.

Development of the access corridor which includes the rail spur line and transmission line will add new lines to the landscape. These lines may cut across existing natural lines such as pipelines and cultivated areas. Creation of new lines on the landscape could develop a jumbled, disorganized, unnatural landscape which could be displeasing to the viewer.

New intrusions such as powerlines, mine buildings, and loading silos will be added to the landscape. Housing which will be needed to meet the demands of expanding population associated with mine employment could add other intrusions to the study area.

Landform will be altered. A general lowering of the elevation of the mined area will take place. Abrupt breaks and changes in topographic relief will be smoothed out at completion of mining. The major change will be the remains of the highwall at completion of mining activities. This will add a new topographic break and depression where none have appeared before.

Impact on aesthetics will take place gradually over a period of time. Intrusions will be added to the landscape prior to and at the beginning of mining. Other changes will take place over a period of 57 years, the projected mine life. The changes to take place on this one site are not significant when compared to the 4.9-million-acre study area. However, the impact of mining on this specific site could be very significant when viewed against the backdrop of surrounding, natural landscape.

Wildlife and Fish

All wildlife will be displaced from the area as mining progresses. The smaller wildlife (reptiles, amphibians, invertebrates, rodents, and other burrowing animals) which are not able to flee will be destroyed. The populations which are displaced such as the estimated 50 to 60 antelope, 17 mule deer, 40 sage grouse, 20 sharptail grouse, plus numerous birds and small mammals will have to relocate on adjacent sites. It is assumed that the surrounding areas are already supporting populations in balance with the available habitat. Therefore, the displaced wildlife may exist for awhile, but the populations will eventually be lowered to remain in balance with the available habitat unless mitigating measures are taken. Part if not all of the displaced population may eventually be lost. The aquatic habitat associated with Rawhide and Little Rawhide Creeks will be lost as mining reaches them.

Loss of wildlife habitat will be a constant progression across the mined property. Once full production of 12 million tons per year is reached by 1983, an estimated 88 acres of vegetation will be destroyed annually. By the end of the mine life, a total of 4,740 acres of habitat will have been destroyed on the mine property. In all probability, the increased human acitivity and noise associated with mining operations will disturb and cause major wildlife species to leave the area prior to destruction of the habitat.

Habitat for the big game species (deer and antelope) and for sage grouse will be lost for a long period of time even though the area will be reclaimed. The projected time periods for return of the area to suitable habitat for various wildlife species groups is graphically shown in Figure 7, Chapter V, Part I. Some animals, especially those associated with a grass

habitat (Richardson's and thirteen-lined ground squirrels, prairie dogs, mice, and other small rodents) will return to the area as it is reclaimed and vegetation reestablished. No satisfactory evidence is presently available which would suggest that strip mined areas can be satisfactorily revegetated with plant communities that will satisfy needs of deer and antelope.

Permanent terrestrial habitat loss will total an estimated 845 acres and includes that associated with relocation of Highway 59, construction of the spur rail line, transmission lines, mine buildings, increased populations, and creation of a lake. This will involve an indeterminable loss of various animal species. Increased recreation use will remove additional acres of habitat and increase pressure on wildlife populations by disturbance and displacement. The use of herbicides for maintenance of powerline and rail spur rights-of-way will remove 343 acres of habitat for animals dependent upon the sagebrush vegetative type.

With increased vehicular use of the area and on surrounding roads, animal road mortality will increase. Mortality will also occur from train traffic. Construction of right-of-way fences and fences to protect the reclaimed area to allow for revegetation to be established may cause some impact on wildlife movement and migration.

Threatened species

No significant impact on peregrine or prairie falcons or on prairie dog colonies is anticipated.

Big game

Almost 100 percent of the total disturbed area related to the Carter mine development is important antelope range. The Carter lease lies adjacent

to crucial antelope winter ranges and may impact total antelope populations to a large degree. The direct impact of development will result in an estimated loss of 50 to 60 antelope from base population and loss of 5,300 acres of antelope habitat.

Mule deer (about 3 per section) will deteriorate with the loss of 3,700 acres of deer habitat.

Other mammals

Predators and furbearers

Increased human activity will eliminate most use of the area by coyotes, red foxes, badgers, and bobcats. Species such as raccoons, skunks, and badgers are less mobile and flexible. Direct habitat removal will initiate a decline in these species. Loss of prey species will especially impact the less mobile species such as badger. Beaver and muskrats are essentially vegetarians. Loss of aquatic habitat in association with riparian vegetation will eliminate or drastically reduce the occurrence of these animals.

Rabbits and hares

Long-term effects will be limited to actual habitat removal, perhaps 300 acres. Stress tolerances are high in these species, and population recovery within their established habitat's capacity may be relatively rapid following successful rehabilitation efforts.

Rodents and bats

Substantial losses of rodents will occur through direct mortality and loss of habitat with initial mine operations and spur line construction and development. Remaining animals will likely move to adjacent areas where

abnormally high densities might temporarily result. Mortality rates then would increase until population densities were again stabilized in relation to remaining habitat.

Where shrub-grass vegetative types are replaced by perennial grassland types, the variety of rodent species and the abundance of individuals will eventually be reduced. Certain species may become more abundant.

Potential impacts to bats are not well understood although presumably effective relocation will occur.

Upland game birds

Destruction or conversion of vegetation (roads, spur line, flooding, mining) will reduce total game bird habitat. An estimated 5,000 acres of sage grouse habitat will be lost. Where sagebrush is destroyed, losses will result for at least the duration of the study period. This amount of habitat provides seasonal or yearlong habitat for a minimum of 40 birds. Sharptail grouse habitat will be lost for an estimated 20 individuals. Eventual "rediscovery" of game birds, including Hungarian partridge and mourning doves, will depend on individual tolerances to disturbance and degree of reestablishment of forage or prey species.

Other birds

Impacts and results will be similar to those described for upland game birds. Powerline construction will result in a specific hazard to large raptorial species of birds. Both inflight and electrocution losses are likely to occur.

Fish

Drastic modification of drainages, rechannelization of habitat, and facility construction all will combine to eliminate or severely change presently available habitat. Existing habitat is fragile and incapable of sustaining fish in the face of extensive modification. If as projected a lake is created at the completion of mining, aquatic habitat may be enhanced and increased.

Recreation

Coal strip mining and attendant activities will diminish hunting resource values. Nearly 4,640 acres will be mined during the life of the mine to 2033. Useable terrain, habitat, and esthetic qualities associated with this acreage, while hunting, will be lost on the lease. Less than 100 hunter days are estimated lost by mining this lease; however, due to the disturbance of all related activities, nearly 900 hunter days will be lost around the area near the lease. Access restrictions, particularly where public land is very scarce, will be imposed because of increased population of 2,070 by 1990.

Mining five to ten miles from Gillette will impose an inconvenience for those who hunt close to the city. Mining activity will disturb wildlife, affect some access to private land previously hunted, and generally require residents of the area to travel 30 to 40 miles farther for hunting. On the Carter lease, some federal land (40 acres) will become physically and legally isolated by mining, reducing the recreation base within the vicinity of Gillette.

Agriculture

Livestock forage

Grazing on the 4,640 acres to be mined will be disrupted by the end of the mine life in 2033. A total of 1,160 AUMs (animal unit months) of annual production will be affected. The disruption will occur over time. Throughout the life of the mine, critical pastures will be destroyed. The acreages and types of pastures are: 864 acres summer pasture and 3,256 acres winter pasture. The remaining acreage of the area is used for grazing but is not as critical as the above named areas.

Relocation of Highway 59 and construction of the rail spur and transmission line will affect a total of 501 acres and 125 AUMs of annual production. Construction of mine plant facilities will disturb an additional 100 acres and 25 AUMs of annual production.

Of the total acreage disturbed, an estimated 240 acres will be permanently removed from production. This area will be utilized by mine facilities, road relocation, and spur rail line bed. A total of 60 AUMs of annual production will be permanently lost. If a lake is created, this will involve loss of an additional 500 acres (125 AUMs).

Facilities which will be destroyed consist of four wells, one spring, and six small reservoirs.

Ranchers presently using this area will be impacted to an unknown extent. Carter has purchased four of the privately owned lands to be most affected and leased them back to the owners for use until mining operations begin.

Farming

The mine property includes 355 acres of cropland. Sixty-five of these acres are utilized for hay production and 290 acres are used for small grain production. This cropland produces 65 tons of hay and 6,160 bushels of small grain annually. Mining will result in the permanent loss of this land for growing crops.

Transportation Networks

If the total surface area within the Carter lease boundaries is disturbed, approximately 2.5 miles of paved highway will be destroyed. Carter intends to relocate State Highway 59 east of the lease area. U.S. Highway 14 and 16 combined will have to be relocated west of the lease area when mining operations reach that portion of the lease. Relocation of each of these highways can be accomplished without upsetting traffic flow by allowing use of the existing highway until the new route is completed.

An estimated 10 to 15 miles of lesser, graded and dirt roads will be obliterated by the mining operation. Alternate routes are available around the lease area, or they can be provided if a ranching or oil well operation becomes isolated. Inconvenience to users and possible farther traveling distance is the main impact. The railroad spur line will temporarily disrupt traffic across some lesser and lightly traveled dirt roads during line construction. Impact is minimal and of short duration. The railroad company estimates that 10 grade crossings will be provided. The spur line will cross under Highway I-90 when the highway is completed. No interruption to highway traffic is expected.

Relocation of pipelines which have to be moved outside the mine area can be accomplished with minimal interruption to the user.

Construction of necessary powerlines to the mine site can be accomplished without disturbance to existing transportation facilities.

Increased traffic created by employees commuting from Gillette to the mine site will induce more rapid deterioration of State Highway 59 with subsequently higher maintenance costs. This highway can probably accommodate the increase in traffic without significant modification. There may be occassional but slight congestion due to increased employee traffic flow.

Socio-Economic Conditions

The primary socio-economic impacts will be those associated with increases in capital expenditures, employment, population, and income.

Estimated capital expenditure at the mine will be 35 to 40 million dollars.

Construction of the mine site will employ from 150 to 200 people for one to two years.

The following table shows estimates of employment, population, and wages induced by the mine. An average annual income of $14,500 in 1976 is expected.

	1976	1980	1985	1990
Mine employment	100	300	300	300
Other employment	200	600	600	600
Total population	700	2,100	2,100	2,100
Wages from mine employment only*	$1,450,000	$5,220,000	$6,525,000	$8,156,250

*Assume inflation = 5 percent per year.

The mine operation will continue until about the year 2033.

Increases in population will increase the demand for services, protection, water supplies, sewage disposal facilities, and housing. Problems associated with more dense populations such as crime, mental illness, and unemployment may increase. These impacts are discussed in Chapter V, Part I.

CHAPTER IV

MITIGATING MEASURES

Air Quality

All activities having an adverse effect on air quality must comply with state and federal air quality standards (Part I, Chapter VI). Stipulations will be included in the approved mining plan requiring such compliance.

Watering of haul roads in the mining area, dust-control measures incorporated in the design of crushing, storage and loading facilities, and enclosed conveyors in the secondary crushing plant will be used to reduce coal dust emissions. Control devices will be used on vehicles and equipment to reduce gaseous and particulate emissions.

Coal fire occurrence will be reduced by keeping the area free of piles of loose coal. Use of fire prevention campaigns will minimize the frequency of fires. Firefighting equipment will be required on the site.

Immediate revegetation (topsoiling, seeding and fertilizing) of spoils will be used and this will reduce short-term air pollution from blowing dust. Storing of initial topsoil and initial boxcut overburden with rough and uneven surfaces will reduce the amount of windblown dust.

Topography

The mining and reclamation plan filed with the Federal Government, in conjunction with federal regulations, state laws, and the coal lease terms, requires actions to mitigate adverse topographic effects of surface mining. Spoils will be graded to a rolling topography, with no slopes greater than 3:1. Highwalls will be reduced. The final pits will be filled with material from adjacent spoil banks and highwalls. The spoil banks, highwalls, and final cuts will then be covered with a layer of soil material to facilitate revegetation. All exposed coalbeds will also be covered by at least three feet of soil material.

The restored land form shall be determined by consultations among the lessee, the appropriate land management agency, the State Lands Commission, and the U.S. Geological Survey. Such consultations will be frequent enough so as not to impede the progress of the mining or reclamation. Prime consideration in grading and shaping shall be the catching and holding of any waters falling on the area to improve the water table and catch and hold sediment in such a manner as to protect downstream areas from excessive sedimentation.

Surface water may accumulate selenium, arsenic and other toxic elements including deleterious salts which become concentrated and deposited along the shore due to evaporation of closed water bodies. Therefore, during the shaping of the spoil into the final landform no closed interior ponds should be permitted to form.

Soils

Impacts to soils can be minimized by including and enforcing protective stipulations in the federal authorizations.

Application of certain land treatment practices will minimize loss of topsoil, productivity, disruption of physical, chemical and biological properties, soil loss by wind and water erosion and compaction. Mitigating measures will include: stockpiling of topsoil for later replacement on disturbed areas, cuts and fills. Mechanized equipment such as scrapers will be used to minimize soil mixing.

Ripping and cultivating the soil surface prior to seeding will minimize soil compaction effects. Restriction of unnecessary off-road vehicle use by equipment operators and employees will minimize soil compaction.

Soil erosion will be minimized by mulching, revegetation and development of water erosion structures including water bars, terraces, contour furrows, grassed water ways and interceptor ditches to divert running water away from unprotected disturbed areas. Wind erosion will be minimized by roughing up smooth exposed soil surfaces with a disc, harrow or similar equipment immediately after clearing is completed. Seeding or revegetation will be accomplished within one year after clearing of vegetation.

Detailed soil inventories will be provided by Carter Oil Company. The inventories will be conducted in accordance with standards designated by the Bureau of Land Management to map and identify each soil series situated within the lease area. Soil samples will be collected to a depth of 60 inches or bedrock for physical and chemical analysis. Chemical tests will include organic matter, pH, exchangeable sodium percentage, boron, sodium, chloride,

calcium, selenium, nitrogen, phosphorous, potash, sulfur, base saturation, cation exchange capacity, and conductivity. Physical tests will include standard soil mechanical analysis and engineering properties. Soil mineralogy and moisture relationships will be determined. Additional soils information will be collected after topsoil has been replaced and before seeding to determine profile, chemical, mechanical and mineralogy changes in the upper 60 inches.

Samples from overburden formations down to the coalbed will be collected for chemical tests to determine presence or absence of toxic or undesirable elements or material. Results from current or past research studies on revegetation and reclamation of disturbed areas will be applied in treating the disturbed onsite and offsite areas.

Construction designs will include mechanical treatment practices such as contour furrows, terraces and mulching to retain moisture onsite to benefit revegetation and reduce soil loss. Design will include control measures such as diversion ditches, water ways and water spreaders to reduce sediment yield and runoff from compacted areas or concentration of runoff waters. Studies and investigations are necessary to identify productive downstream soil units that are presently sustaining desirable vegetative communities from being deprived of soil moisture.

Disposal areas for solid and liquid wastes will be located upon sites that will not have detrimental effects upon the environment and in accordance with state and federal regulations. Service haul roads; material sites for sand, gravel ballast; campsites; and equipment storage areas will be cleaned up, scarified, rehabilitated to near natural condition and revegated. The edges or vertical sides of all excavated material sites and

borrow areas will be sloped to a minimum 3:1 slope to minimize sloughing and enable revegetation. Contingency plans must include measures to cleanup accidental spillage of detrimental or toxic materials such as gasoline, oils, chemicals and restore damaged soil to a near natural condition.

Service and haul roads that are susceptibale to producing dust and sediment will be surfaced or treated with a binder of water. Chemical binders, surfacing materials and use of herbicides must meet state and federal approval.

Water Resources

Availability of water from deeper aquifers

Water-well supplies affected by lowered water levels in the radius influenced by dewatering for mining could be replaced by deeper wells. The chemical quality of water in the Fort Union Formation is similar or of better quality than water in the overlying Wasatch Formation.

Monitoring programs

Monitoring programs are being established by companies planning to mine coal. A number of the monitoring programs are being planned in consultation with the Water Resources Division of the U.S. Geological Survey. The programs consist of establishing observation wells to determine water-level fluctuations in the coal and the overlying overburden. Water samples will be collected to determine the chemical quality of the water for detecting changes in water quality after mining begins. As mining progresses, observation wells will be established in backfill areas to monitor for leaching and movement of toxic materials.

Vegetation

The loss of vegetation on land disturbed by coal mining and related activities will be mitigated by satisfactory revegetation. Initial measures will be started within one year following reshaping of the land and replacing of topsoil. Revegetation efforts will continue until a satisfactory stand of vegetation is established that will grow without irrigation.

Plans to revegetate disturbed land will be approved by the administering agency. Stipulations will be developed and included in the mining plan to meet the revegetation objectives. Additional stipulations that will be considered are listed below.

Damage to native vegetation will be minimized by maintaining the acreage of disturbed areas (powerline right-of-way, railroad spur right-of-way, roadways, coal processing and transporting facilities, buildings, etc.), to an absolute minimum.

Depositon of dust and harmful chemicals on vegetation will be reduced by watering haul roads and installation of dust suppression controls on mining, transporting, processing and loading equipment.

Completion of a detailed vegetation survey (currently being conducted for Carter by personnel from the University of Wyoming) will provide protection for important plant communities on or adjacent to the coal property area.

Archeological Preservation

Legislative authorities and obligations which guide issuance of federal license to develop the Powder River coal resources are the statute commonly referred to as Antiquities Act of 1906 (34 Stat. 225, 16 U.S.C. 431-433); Wyoming statutes relating to archeological and paleontological sites (sections 36-11 to 56-13 and 18-330.7 W.S. 1957); an act for salvage at reservoir sites (74 Stat. 220; 16 U.S.C. 469-469c); an act for historic preservation (80 Stat. 915, 16 U.S.C. 470-470m); National Environmental Policy Act of 1969 (83 Stat. 852, 42 U.S.C. 4321 et seq); and Executive Order 11593, May 13, 1971 (36 F.R.-8921).

Both federal and state antiquities acts regulate antiquities excavation and collections, and both protect historical values on public lands. They provide for fine and/or imprisonment for violaters of their provisions. The reservoir salvage act provides for recovery of historical and archeological data from areas to be inundated by certain water impoundment, as a result of federal action. The Historic Preservation Act established a system of historic preservation in the nation and requires that certain federal undertakings be submitted for review by the National Advisory Council on Historic Preservation. NEPA states in Section 101(b)(4) that one objective of national environmental policy is to "preserve important historic cultural and natural aspects of our national heritage and maintain, wherever possible, an environment which supports diversity and variety of individual choice." Finally, Executive Order 11593 affects federal agencies most intimately in that they are instructed to cooperate with the nonfederal agencies, groups, and individuals and to insure that federal plans and programs contribute to the preservation and enhancement of nonfederally owned historic and cultural

values. Agencies are directed to inventory, evaluate and nominate properties in their jurisdiction to the National Register of Historic Places.

Under the mandate of the Executive Order, federal agencies must insure that until inventories and evaluations are completed, the agencies will use caution to assure that federally owned properties which might qualify for nomination to the National Register of Historic Places are not inadvertently transferred, sold, demolished or substantially altered and that federal plans and programs contribute to the preservation and enhancement of non-federally owned sites.

The Antiquities Act of 1906 prohibits damage or excavation of plant and animal antiquities on federal lands without a permit (see 43 CFR Part 3). The Wyoming statutes require that permits be obtained before excavation on any archeological or paleontological deposits on either state or federal public lands (sec. 36-11 W.S. 1957).

Archeological and paleontological values on federal lands will be protected by surveys and salvage excavations. Federal ownership of the subsurface estate extends similar protection to the federal holdings underlying privately owned surfaces. The Wyoming Antiquities Act similarly requires a permit for excavation of antiquities on public lands, permission to be granted by the State Board of Land Commissioners.

Surface surveys for evidence of archeological values in the alluvium are fundamental to establishing responsible stipulations for their protection. Therefore these stipulations in the mining plan and/or permit that require surveys will be followed to insure archeological and paleontological protection.

No mining plans or rights-of-way will be approved until the company has coordinated its archeological surveys with the Wyoming State Historic Preservation Officer (State Archeologist). Company survey reports will be submitted to the State Historic Preservation Officer with a copy to agencies approving plans and permits. The report will be certified by the Preservation Officer and forwarded to the approving agencies, with a statement that surveys have been conducted by competent, professional archeologists and a recommendation for additional surveys to be required before plans and permits are approved. These additional surveys may be necessary if surface evidence indicates further evaluation is necessary. In addition approvals will be conditioned to require notification to the Area Mining Supervisor of all archeological and paleontological sites discovered during mining prior to disturbance and notification to the appropriate officer of the surface administrating agency of sites discovered during right-of-way construction prior to disturbance. The Antiquities Act of 1906 and Wyoming statutes make it unlawful to excavate sites which are discovered without a permit.

Furthermore, it will be required that the alluvium to be displaced during the mining operation be surveyed and that all surveys be coordinated with the Wyoming Historic Preservation Officer to insure competent, professional inventories, salvage and preservation of archeological and paleontological data.

It is recommended that all present and future applicants share in the cost of establishing a full-time resident basin paleo-archeologist under the supervision of the State Historic Preservation Officer. The basin archeologist will aid in reducing lead time and development delays by performing advance surveys for support facilities, educating construction employees, sampling soils, responding to company discoveries and conducting salvage work.

Historical Values

According to the State Historian, the possibility always exists that new information may be discovered that could place a value on previously unimportant sites. If this occurs, the appropriate acts shall be used to determine the course of action to be taken by the agency having jurisdiction on the land.

Aesthetics

The Carter mining plan will contain stipulations guided by Departments of Interior and Agriculture visual resource standards. Plant silos and powerlines will be designed to blend with natural landscape to the extent possible.

Probably the most critical factor in reducing the impact of a lineal project is its location in relation to naturally occurring lines in the landscape. Lineal projects will be located where natural lines already occur, following contours, depressions and avoiding a crossing at the crest of a hill.

Topsoil will be stripped off and replaced over reshaped natural land forms. Native vegetation will be used where practical and seed is available. Plantings will be irregularly seeded to break the unnatural lines of construction. Disturbed areas will be kept to a minimum and high walls back sloped to a maximum of 3:1. Non-reflective materials will be used on transmission lines, towers, buildings, silos, conveyors and crushers, e.g., unpainted concrete on the silos.

Wildlife and Fish

Measures which will result in mitigation of impacts on some wildlife species are primarily those which will come about as result of attempts to reestablish grasslands for livestock forage and watershed protection. Carter Oil Company has purchased over 90 percent of the surface lands in their development area. They have stated that they may go into the ranching business after mined lands have been reclaimed. The existence of legal authority to require private landowners to restore specific types of habitat or specific amounts of key or crucial habitat is doubtful. Should existing laws and regulations be interpreted as imparting some authority to require the above, their effectiveness and enforceability would be equally open to serious question. In short, existing legal authority cannot be expected to insure mitigation of most specific losses where the mitigation may conflict with the interests of private landowners. Existing state and federal air, water and land quality laws will insure some mitigation of impacts through broad requirements of revegetation, non-degredation of water quality and reduction of gross air pollution. These legal authorities, if enforced, may significantly reduce total and long-term impacts on animals such as fish, waterfowl, and some birds, rodents and invertebrates. They can be expected to have only slight mitigating effects on total impacts on other species.

Opportunities for mitigation of wildlife losses, as opposed to legal requirements for mitigating are more available. Serious attempts to provide a variety of topography, reestablish shrub and riparian land ecosystems and expand aquatic habitats could be expected to meet with sufficient success to mitigate at least part of total long-term impacts on a variety of species. Due to the nature of mining operations and the long time period required to reestablish

these vegetative types their mitigation would be little realized before the end of the study period (1990).

A variety of native species representing shrub, forb, and grass groups should be well represented. Palatable varieties of big sagebrush and rabbitbrush as well as skunkbush sumac, chokecherry, and juniper would help mitigate losses of deer, antelope, sage grouse, sharptails and non-game species. Varied topography would increase habitat diversity and result in greater variety and abundance of wildlife.

Right-of-way fencing and other fencing barriers and hazards to deer and antelope movement could be reduced by using less fencing, using fences passable to antelope and deer and using various crossing structures. These measures should be planned and located on the ground with the State Game and Fish Department as the development proceeds.

Ponds or lakes created as a "by-product" should have irregular shorelines and islands to create the maximum amount of shoreline. Some shorelines should slope gradually to provide shallow, marshy areas and encourage emergent vegetation while others should have steeper shorelines to discourage emergent vegetation, thus increasing diversity. Shallow ponds would have the greatest value for waterfowl and deeper ponds the greater value for fish.

Reestablished riparian vegetation along drainage courses and around aquatic habitats would eventually result in reestablishment of many animals associated with this habitat type (Table 11, Chapter V, Part I).

Potential also exists to enhance offsite habitat which would offset losses created by mine development.

Recreation

If any requests for water impoundments are made on the Carter lease covering federal lands or minerals in areas of important cultural and recreation values, impact assessment and protection can be given through the authority granted by the Reservoir Salvage Act of 1960 and the National Environmental Policy Act of 1969.

If a reservoir planned for construction covers federal surface or mineral and has for its use, water designated for another federally approved project, it will be assessed under the requirements of the National Environmental Policy Act and salvage requirements under the Reservoir Salvage Act. If cultural values are located the "criteria for effect" under Section 106, of the National Historic Preservation Act and Section 2b of E.O. 11593 will be initiated by any federal agency joined in the project.

Where scenic, historic, and recreation values are impacted, either on or adjacent to federal land, it will be required that agencies constructing new federal aid highways study locations and alignments that complement these resources as stated in the Federal Aid Highway Act of 1973.

The Carter mining plan, in conjunction with land reclamation, will insure enhancement of any planned lakes or ponds by providing stipulations for shorelines and slopes that improve fishing and waterfowl nesting. These will improve sightseeing and hunting opportunities for area residents.

Agriculture

Livestock grazing

Measures that may be taken to minimize the affects of mining on livestock grazing should be initiated at the appropriate stages of the mining procedure.

Coal to be produced will require between 70 and 150 acres be taken out of forage production annually. Temporary fences should be erected around the areas actively involved in mining so the remainder of the area will be available for livestock use and hazards from highwalls and mining equipment to livestock will be minimized.

Topsoil will be stockpiled in sufficient amount to provide for placement on spoil piles at a depth not less than six inches. This will enhance plant establishment and growth during reclamation.

Where operations could result in acid or saline drainage or sedimentation in streams, provisions will be made for impoundments. Impoundments will not affect adjacent landowners or contribute to water pollution. Water capable of supporting fish and other aquatic life should be the goal of any impoundment. When feasible, erosion control and flood control structures should be built prior to excavation.

Open burning of all materials will be in accordance with suitable practices for fire prevention and control, and state regulations.

Abandoned highwalls will be reduced to slopes no steeper than 30 percent. Spoil piles will be reduced to slopes no steeper than 30 percent, topsoil spread at a depth not less than six inches in depth, and revegetated as soon as practical. Denuded areas will be mulched and disked on the contour pattern, to reduce runoff, erosion and sedimentation. Adequate mulching will be maintained until revegetation specifications have been met.

Prepared spoil areas will be seeded with recommended seed mixtures. Seed will be drilled into the soil to a depth of 1/2 to 3/4 inch and on a contour pattern. Two years shall be a proper interval to determine if an adquate stand has been established. Two tries to establish an adequate stand will be considered adequate. Two years after an adequate stand of vegetation has been realized, the fences will be removed and the area made available for livestock grazing.

Water wells to be breached will be plugged with concrete to a point not less than 20 feet below the final mine floor level. After spoil rehabilitation is complete, new wells will be drilled to replace those destroyed. Metal and all other nonmineral material waste will be buried or removed and disposed of. Noxious and toxic species of invader plants will be controlled by using approved herbicides. The owner will be reimbursed at the appraised price for the loss of all facilities destroyed by mining activity.

Farming

Measures that will minimize the affect of mining activity on farming must be adequately timed. The following measures will be considered minimal in an adequate mining plan.

Acreages to be prepared for mining should be posted one year prior to anticipated activity to prevent economic loss due to unnecessary summer fallow operations or destruction of growing crops. Written notification to operator of cropland will be sufficient.

No less than one access route will be maintained to each cropped field. Temporary fencing will be installed to protect crops from destruction by drifting livestock when permanent fencing is destroyed by mining activity.

Active highwall areas will be posted with hazard warning signs. Abandoned highwalls will be sloped to a grade not exceeding 30 percent. Abandoned spoil piles and denuded areas will be mulched to reduce accelerated erosion and sedimentation due to wind or water. The mulch shall be disked into the surface. Active areas, such as haul roads, will be treated to reduce windborn mineral particles.

Transportation Networks

To mitigate impacts on traffic flow due to highway relocation it will be necessary to allow traffic to travel undisturbed over the existing and until the realignment is completed. It will be necessary to provide alternate routes of access to any ranching or other local operations that will be isolated due to obliteration of roads within the mining lease.

CHAPTER V

PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Air Quality

Adverse impacts on air quality resulting from development of the Carter mine property cannot be avoided. Some coal and soil dust created by mining 636.8 million tons of coal, disturbing a total of 5,241 acres (4,740 mined and facilities - 252 rail and access road construction - 42 highway relocation - 207 powerline construction), over the 57-year period will occur. About 88 surface acres will be disturbed in any one year and 300 to 500 acres may be bare at any one time.

Even with proper emission controls, emissions from vehicles, equipment and accidental fires will occur, causing a reduction in air quality on the lease site and downwind. As no effective emission controls exist for diesel locomotives, emissions from train operations cannot be avoided. These emissions are expected to reach a peak by 1985 and remain fairly constant thereafter. Table 1 compares the projected unavoidable train emissions with the 1970 quantities for the Wyoming intrastate air quality control region.

Table 1

Unavoidable Train Emissions Versus 1970 Total Emission for
Wyoming Intrastate Air Quality Region
(tons/year)

	1970	1980		1985	
Type	Base	Increase*	% Increase	Increase*	% Increase
Particulates	23,510	26,514	0.01%	26,521	0.04%
Sulfur Dioxide	38,202	38,212	0.03%	38,228	0.07%
Nitrogen Oxides	28,647	28,714	0.20%	28,814	0.60%
Carbon Monoxide	122,428	122,452	0.02%	122,487	0.05%
Hydrocarbons	21,635	21,651	0.07%	21,677	0.20%

*Base plus train emissions

Topography

A reduction in altitude caused by mining thick beds of coal with thin overburden cannot be avoided. The decrease in altitude over the lease area will range from a maximum of 105 feet to a minimum of a few feet. The average drop will be about 62 feet.

Destruction of natural features of the landscape is unavoidable. Even though the general topography of the area can be restored at a lower level, cliffs and abrupt breaks, presently a part of the topographic scene, cannot be restored. The exact slope and angle of the present topography is unrestorable.

Change in the drainage channel of Little Rawhide Creek and its tributaries cannot be avoided.

Soils

Disturbance of topsoil on a total of 5,241 acres (4,640 mined - 100 mine facilities - 252 rail and access road - 42 highway relocation - 207 power-line construction) cannot be avoided. Loss from productivity of 345 acres of soil (access road - railroad bed - mine facilities - housing) and of 500 acres from inundation by a lake is unavoidable. The disturbance of topsoil will lower to some degree the natural soil productivity of the area by compaction, mixing natural soils, and causing accelerated soil erosion.

On the 4,640 acres to be mined, complete destruction of all soil horizons parent material and soil characteristics which have developed over long periods of geologic time cannot be avoided. The present soil biota and soil forming processes will be terminated. Once mining is completed and the area reclaimed, soil development will have to start again. As an end result, new soils will be formed with characteristics totally unlike the ones existing prior to mining.

Reduction of soil productivity and permeability and infiltration rates is unavoidable. Increase in erosion and sedimentation rates will occur, but amount of soil loss through time cannot be determined.

Mineral resources

The mining and removal of coal cannot be avoided under present plans and proposals. The proposed mining activity will have an unavoidable adverse effect on the coalbeds, coal resources, and coal reserves in that deposits of a nonrenewable mineral commodity will have been mined. By 2033 this comprises 5.1 percent of the estimated economically recoverable strippable coal reserves identified in Campbell and Converse Counties. Loss of minor amounts of coal in mining, loading, and transportation operations is unavoidable.

Water Resources

The amount of water consumed in mine operations will be unavoidably lost. The amount cannot be quantified. Aquifers removed by mining will be permanently lost. However, the effect of this loss will be of local extent.

If a lake is left as has been projected, it may deplete streamflows and will add to evaporational loss of water which then is not available for other uses (agriculture - stream habitat).

A reduction in water quality from increased erosion and sedimentation will occur to some degree. The amount or degree cannot be estimated.

Vegetation

Vegetation will be temporarily destroyed on 5,241 acres and permanently removed on 845 acres. These losses associated with mine operations, rail spur construction and increased population and creation of a lake cannot be avoided.

Reclamation of areas disturbed by rights-of-way will occur shortly after disturbance. However, success of revegetating the severly disturbed mined area is unknown at this time.

All plant succession is unavoidably destroyed at the time of disturbance. Fifty years or more of plant succession will be required for these areas to return to their present state as existing soil structure and microclimate have been changed and altered.

Even on areas that are successfully reclaimed, a 50 percent loss in productivity has been projected.

Archeological and Paleontological Values

Subsurface material and sites will be damaged or destroyed under the most responsible mining program, with much more lost to indifference from surface activities of population expansion.

Some losses, removal of 104 acres to regional expansion will be expected from lack of surface evidence, time, money, and trained personnel to conduct regional surveys.

Limited interpretive and educational material on the collected data will contribute to uniformed damages by construction activities and regional residents.

Aesthetics

The added structures, roads, rail lines, and powerlines will be discordant intrusions added to the natural landscape. The natural landscape (shape - texture - color) will be changed unavoidably. To some, this will be an adverse alteration of the natural landscape.

Even after reclamation, the disturbed areas will be discernible for a long period of time.

Wildlife and Fish

Loss of habitat and reduction in population will occur. The smaller wildlife (reptiles, amphibians, invertebrates, and other burrowing animals) which cannot flee will be destroyed. An estimated 50 to 60 antelope, 17 mule deer, 40 sage grouse, and 20 sharp-tailed grouse will be displaced and probably lost.

Destruction of 5,241 acres of habitat will reduce the carrying capacity of wildlife habitat in this area. Successful return of wildlife habitat for most animals will require a period of from 20 to 50 years. (Figure 7, Chapter V, Part I). The permanent removal of 845 acres of terrestrial habitat will be unavoidable.

Increased population will intensify recreational use of the area. This will adversely impact a larger area of wildlife habitat than that actually disturbed by mine activities. As much of this area is critical antelope habitat, the overall unavoidable impact may be loss of a larger number of antelope than projected.

The aquatic habitat and fish life associated with Little Rawhide Creek will be unavoidably lost.

Recreation

Loss of an estimated 100 hunter days of use on the site and 900 hunter days per year in the immediate area cannot be avoided.

Reduction of wildlife habitat, population, and quality will lessen hunter opportunities. Increased population will intensify recreational use, which could cause adverse reduction of recreation quality and deterioration of facilities. Loss of recreation land base in close proximity to the Town of Gillette is unavoidable. This loss will span the 57-year life of the mine.

Agriculture

Livestock forage

Permanent loss of 740 acres of forage and 185 AUMs cannot be avoided. Destruction of four wells, one spring, and six small reservoirs is unavoidable. However, the wells will be replaced at other locations. Reduction of livestock water will result in a loss of grazing capacity.

Temporary loss of forage during mining operations cannot be avoided. Reduction of an estimated 50 percent in carrying capacity after reclamation cannot be avoided. This will cause an annual overall yearly loss of 518 AUMs, assuming the entire area will be successfully revegetated.

Destruction of critical pastures (4,120 acres) and the necessity of the rancher having to provide pasture elsewhere is unavoidable. Added economic cost of the rancher having to provide new water sources for his livestock cannot be avoided.

Farming

Serious doubt exists about the success of rehabilitating the mined lands for crop production. It is very probable that crops will not be able to be grown on the rehabilitated surface. This will result in the permanent loss of the use of 355 acres for cropping.

Hay production will be 65 tons less, and approximately 6,160 bushels of small grain will not be produced annually. Since much of this production was sold as a cash crop, farmers will not realize the net cash gain realized from these crops. In instances where the crops were used for livestock feed, it will now be necessary to replace them through purchase.

Transportation Networks

Increased traffic on all existing facilities cannot be avoided. The increase will begin in 1975. Road maintenance costs and frequency will increase and these costs cannot be avoided.

Temporary inconvenience and poor travel conditions caused during construction of such facilities as the rail line, relocation of highway 59, and transmission line are unavoidable. These impacts will be minor and occur only over a short time span. It is impossible to predict the possible increase in train/car accidents. With the number of trains required per day (6 by 1985), the increase probability of these accidents occurring cannot be avoided.

Socio-Economic Conditions

Unavoidable adverse effects of this mine cannot be quantified at this level. The cumulative impacts are anlyzed in Chapter VII, Part I.

CHAPTER VI

ALTERNATIVES TO THE PROPOSED ACTION

Approve the Mining Plan After Modification

Some impacts identified and discussed in Chapter V could be avoided if the mining plan were modified to require the use of one or more of the operational alternatives discussed below. In addition, special conditions could be added to the plan relating to secondary effects of the mining. Such conditions must be reasonable and, if unacceptable to the lessee, could result in the lessee not developing the area with the resultant impacts discussed under the heading "No New Development of Coal" and "Alternate Reclamation Objectives" in Chapter VIII, Part I.

Different methods of mining

Underground mining

Substitution of this method of mining would result in less initial disturbance of the land surface; greater costs because underground mining would be more costly than surface mining; a decrease in mine safety as indicated by the fatal accident rates in 1972 of 0.42 per million tons mined underground compared to 0.07 per million tons for surface mining; and higher incidence of nonfatal accidents due to roof and coal falls, fires, explosions, and problems related to dust inhalation (black lung disease).

On Carter Oil Company's federal leasehold, the two coalbeds average 107 feet in thickness. Assuming that a 10-foot section in each bed could be mined safely by underground methods and that 50 percent of coal in the mined

area was left in place to provide support and lessen the probability of surface subsidence, coal extracted would represent about nine percent of the available coal in place. This rate compares to an expected recovery of 90 to 95 percent of the available coal in place using surface mining methods.

In-situ production

Techniques for the economical burning of coal in-situ and capture of the released volatile gases are still in experimental stages. Present knowledge indicates that energy recovery levels of in-situ production are low and amount of surface subsidence in areas of thin overburden is highly unpredictable. Impacts associated with in-situ production would include the possiblity of destruction of a coalbed aquifer, pollution of ground water, and air pollution from escaping gases.

For in-situ production to be a viable alternative technique, methods for increased recovery of volatile gases must be developed. Such increases could then allow in-situ production to compare favorably with the high recovery of coal by surface mining methods.

Auger mining

Auger mining should not be considered as a realistic or viable alternative to surface mining because it is not used except under specific conditions. Auger mining is used to recover coal along a highwall of an existing surface mine which has reached its maximum overburden limits. The effective penetration depth is limited to less than 200 feet, and the auger diameter is presently limited to 84 inches. In beds less than 7 feet thick, recovery is less than 40 percent and would be considerably less for Carter's 107-foot total coal thickness. Auger mining is not applicable on Carter's leasehold to sufficiently supply the quantities of coal demanded.

Different rate of production

Carter Oil Company has contracts to supply 3.6 million tons of coal per year in 1977 to the Indiana and Michigan Electric Company, esclating to 5 million tons in 1978, and are projecting a further escalation to 12 million tons in 1983.

Any change in production rate, either upward or downward, would alter the rate or intensity of the environmental impacts discussed previously in this statement. If a reduction in proposed production rate were required, it would create a shortage of fuel at the power plants in the area of consumption and result in decreased production when consumption is increasing unless substitute sources of supply were obtained. A reduction would also prolong mining activity on the leasehold, prolong the time until restoration is completed, lessen employment at the mine, lessen the acreage disturbed at any one time, and lessen annual tax and royalty returns to the state and county.

If the company were required to increase production above the level proposed, it would cause storage problems with the possibility of fires in storage areas unless additional new markets were found, increase the intensity and severity of the impacts described elsewhere in the statement, decrease the length of time for mining and reclamation, and increase annual tax and royalty returns.

Different utilization

Onsite power generation

Transportation and fuel costs for onsite electric power generation would be minimal, and there would be less chance for coal spilling than during transportation to offsite power generation plants. However, a coal-burning electrical power generation plant would have to be constructed, transmission

lines would have to be built, and the generating plant would have to be connected into the existing power distribution network. For a cooled plant, large volumes of water and water rights would have to be obtained and pipelines and storage facilities built to supply an onsite steam generating plant. The electrical stations in the area of consumption would lose the supply of coal for which they were designed unless coal of like quality from another mine in the area was substituted for coal from the North Rawhide mine.

Local environmental impacts that would result from onsite power generation would be degradation of air quality by stack emissions; land-use problems related to ash disposal; noise from the generating station; the large quantity of water needed must be diverted from other uses; degradation of scenery by the generating station, transmission lines, and support facilities; dust related to coal handling, processing, and ash disposal; loss of land used by the generating station and support facilities from other uses; and increased employment and related economic benefits. Impacts associated with mining and reclamation would remain the same.

Other offsite markets

To supply coal to offsite electrical power generating plants would have the effect of transferring transportation and other end-use impacts elsewhere. These impacts have been described heretofore in the statement. The impacts associated with mining and reclamation would remain the same if the proposed production rate was not increased. If increased, the severity and duration of these would also be increased.

Different methods of coal transport

Pipeline transportation

Transporting coal in a pipeline as a slurry could be required as a possible alternative. An advantage would be less surface pollution by wind-blown or spilled coal from railroad cars. The time and capital cost of planning and constructing a pipeline from the North Rawhide mine to the proposed mainline railroad is unknown. Based on the Black Mesa pipeline, however, the cost would be in excess of $128,000 per mile (Love 1969).

Impacts of this alternative, in addition to cost, would be the securing of a pipeline right-of-way to the proposed railroad at least 75 feet in width and land for in-line support facilities, the obtaining of water rights for the large volumes of water for slurry preparation and pipeline transportation, 240 gallons of water per ton of coal, the construction of water and slurry storage facilities requiring additional surface disturbance at some localities along the right-of-way, the construction of additional processing facilities at the mine to prepare the coal for transmission as a slurry, the construction of dewatering facilities, the loss of a large tonnage of steel pipe to other uses, the loss of the energy required to construct and run such a coal slurry pipeline to other uses, the possibility of pipeline spillage and rupture which could degrade local areas, and the construction, at the point of consumption, of facilities to remove wet or frozen coal from the coal cars.

Highway transportation

Substitution of truck haul for railroad haul would not cause additional surface disturbance at the proposed mine. Existing county and state, and federal roads would have to be redesigned and rebuilt to withstand the stress of constant

coal-loaded truck traffic. Large numbers of trucks would create increased noise, pollution from truck emissions, and increased safety hazards for the public.

Reject Mining Plan

Rejection of the Carter mining plan would result in no environmental impact on the leased lands, and they would continue in their present condition or be modified by the surface owner to meet other uses. The Carter Oil Company could submit a new mining plan, challenge the rejection, or abandon--at least temporarily--development of the lease. Should the mining plan be rejected, development of alternate sources of energy or reduction of energy consumption would be required.

Carter may also begin mining operations on its holdings of state or privately owned coal in the same locality with the same primary and secondary impacts as those evolving from the mining of both federal and private coal. Such mining would result in a number of small mines in the privately owned lands, leaving the federal coal untouched. Such a pattern, where federally owned coal is not mined, would increase extraction costs, create an indeterminate number of small, isolated strip mines on privately owned coal lands, result in increased mining problems and costs if the federally owned coal were later extracted, and result in a loss to the state and county of taxes and a loss of the state's share of revenue distributed in accordance with the Mineral Leasing Act. In addition, reclamation and enforcement requirements under state laws could be either more or less stringent than those required by the Federal Government, thereby affecting the restoration of mined areas.

In the event Carter chose not to mine on privately owned land as a consequence of rejection of a mining plan on the federal leasehold, coal for the power plants they are to supply would have to be obtained from another source.

CHAPTER VII

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Mining will result in the introduction of new roads, buildings, trackage, powerlines, and heavy equipment into an area not appreciably changed from its natural state except by Highway 59, an oil pipeline, and transportation routes and attendant structures associated with grazing and farming activities.

The lease area will be committed to coal production for a period of about 57 years based on anticipated production levels.

As coal is mined, the overlying soil and rocks will be removed, and the affected acreage will be lost to grazing and rangeland recreation for a period of five or six years.

Impacts arising from the short-term use of the environment will be minimized to the greatest extent practicable consistent with modern mining and reclamation practices. Grading of spoils will reduce ridges to a rolling topography aesthetically consistent with surrounding undisturbed areas. Replacement of soil material and establishment of vegetative cover will return mined land to grazing as soon as possible following extraction of the coal.

Mining will temporarily disrupt the flow of surface water. Ground water levels may be lowered locally because of the removal of parts of aquifers in unconsolidated material, sandstone, and coalbeds. Rainwater and water flowing into the mined area will probably be retained by infiltration into the spoils, creating perched water tables.

The preceding indicates that short-term use of parts of the leasehold for mining will be accompanied and followed by a period of reclamation

and revegetation. Although the land's appearance will be permanently changed, its attractiveness should not be adversely affected. Other potential long-term land uses may be impaired by introduction of heavy industry, housing developments, and development of other resources. In addition, coal used for power generation will not be available for other uses or for future use.

At maximum production, 88 acres will be disturbed by mining each year with an equal number of acres undergoing grading and planting. At any one time, the total area disturbed will be about 500 acres. Since final reclamation of a particular area is estimated to lag about five years behind mining, wildlife and livestock will be displaced for at least that period of time.

In summary, the land will be used for mining coal rather than for grazing and wildlife habitat for a period of five to ten years at which time the land should be restored to its former or other designated uses.

Disturbed land, presence of heavy equipment, other mine-related facilities, and associated noise, dust, and solid waste will be only of short duration. After mining, reclamation, and revegetation is completed, the principal long-term changes will be local modification of the topography and surface drainage systems and loss or reduction of productive capacity.

It is estimated that total productive capacity of the land will be reduced 50 percent over present levels even if revegetation is successful. Reclamation techniques in this semiarid climate have to be tested before any final predictions can be made as to success ratios.

Wildlife habitat for those animals which depend on a sagebrush type (antelope - sage grouse) will be destroyed for a period of 20 to 50 years.

Figure 7 in Chapter V of Part I shows the time span from point of disturbance which is required for replacement of adequate habitat for various animal groups.

If a lake is created as projected and provided that water quality is sufficient to sustain fish life, the long term aquatic production of the site will be improved.

Mining of this area will involve a long-term loss in productivity. Under the climatic conditions which prevail for this area, the area may never regain its present productive capacity.

CHAPTER VIII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The major commitment of resources is the mining and consumption of 636.8 million tons of coal over the 57-year life of the mine. This loss represents about 5.1 percent of the economically strippable reserves of the Eastern Powder River Coal Basin.

Use of an indeterminable amount of sand and gravel and clinker for aggregate in the construction of mine facilities, railroad spur and access road will occur. Clinker, sand, and gravel deposits mined with the overburden and moved with other spoil will be irretrievably lost.

The only ground water aquifers that will be irreversibly committed are those aquifers that will be physically removed during mining. Adjacent parts of these aquifers will be affected during mining operations but water levels are expected to return to normal after mine dewatering stops. The chemical quality of water in the aquifers will not be changed.

The extraction of coal and reclamation of disturbed areas will require the use of electrical power, lubricants, liquid fuels including diesel fuel and gasoline, ammonium nitrate explosives, and structural materials for construction and repair of surface buildings. Chemicals and materials used in mining and reclamation would also be lost for other uses.

Large amounts of diesel fuel will be used in transporting the coal via rail line. By 1985 the consumption of fuel just on the spur line will amount to 912 thousand gallons per year. This fuel will be consumed and unavailable for future use.

Loss of life will occur both in the mining operations and associated with increased vehicular and train traffic. Based on fatal accident rates experienced in the strip mining industry during 1972, one employee will suffer a fatal accident for every 14.3 million tons of coal produced. Disabling injuries will occur at the rate of 9.24 per million man hours worked. Therefore, during the life of the mine an estimated 45 people will lose their lives. This will be an irretrievable commitment of human resources.

Any destruction of archeological or paleontological values will be an irreversible commitment of resources.

It is doubtful that total reestablishment of the complex native plant community is possible on disturbed areas of the mined area. Strip mining and associated activities will eliminate a portion of this life-support community which is the major irreversible impact to wildlife in the area.

Wildlife resources that may be irretrievably lost include individual animals and habitats that are destroyed. Animals and plants that would have reproduced in the affected habitats during the life of the mining operation may also be irretrievably lost. Most wildlife losses may be reversible if the species and habitat are not impacted to the point that their ability to reproduce is seriously impaired.

It is doubtful that full production can ever be restored to areas severly disrupted by strip mining. The assumption has been made that even upon revegetation, productive capacity will be reduced to 50 percent of previous capacity. Until further research is conducted, this has to be considered an irreversible commitment of resources.

The annual forage production which the area could have produced will be lost during the time that mining takes place. Production could be lost on

300 to 500 acres annually. This increment of production lost is an irreversible commitment of the livestock forage.

CHAPTER I

DESCRIPTION OF THE PROPOSED ACTION

Background and History

The proposed Jacobs Ranch mine of Kerr-McGee Coal Corporation is on 4,192 acres of land in Campbell County, Wyoming, (Figure 1), and is one of the proposed coal mines in the Eastern Powder River Basin whose cumulative impact is being considered in this environmental impact statement.

An application for a coal lease, W-7456, covering a portion of the present Kerr-McGee Lease was filed with the Bureau of Land Management on July 17, 1967. A Land Office decision on April 21, 1970, attached additional lands to the lease block and established that the lease would be offered for competitive bidding. The original application for coal lease was withdrawn on May 6, 1970, clearing the way for the competitive lease sale on the enlarged tract which was held on June 23, 1970. Kerr-McGee Corporation offered the high bid of $52.00 per acre during oral bidding and was awarded the lease on September 1, 1970. This lease was numbered W-23928 for that portion of the tract on public domain lands and W-24710 for that portion of the tract on acquired lands. Copies of both leases are in Appendix D.

These two leases with the Bureau of Land Management are continuing leases subject to reasonable readjustment of terms on a 20-year basis. They provide for a royalty of 17½ cents per short ton (2,000 pounds) of coal mined for the first 10 years and 20 cents per short ton of coal mined for the remainder of the first 20-year lease period. Annual rentals are set at $1.00 per acre for the first five years of the lease and $5.00 per acre for the sixth

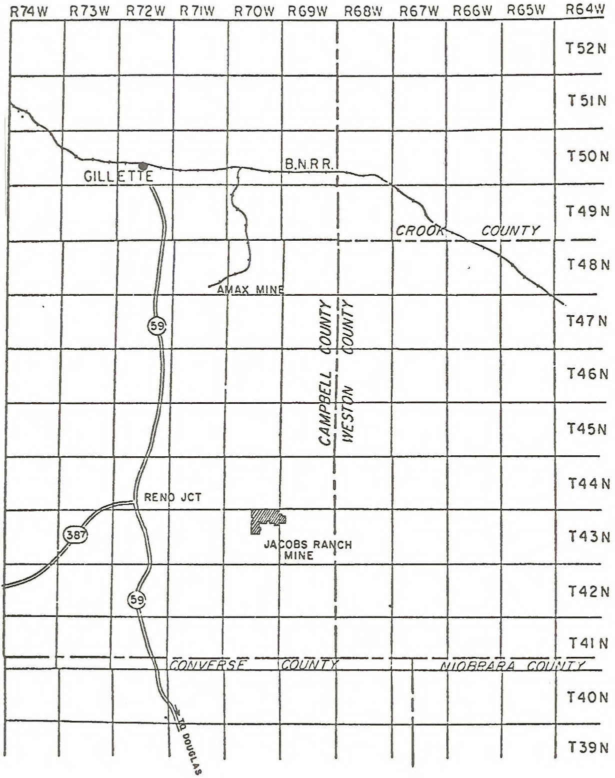


Figure 1

Location of the Jacobs Ranch Coal Property of the Kerr-McGee Coal Corporation

Cambell County, Wyoming

and each succeeding year. Annual rentals after the sixth lease year revert to $1.00 per acre if the production royalty for the lease year equals or exceeds $5.00 per acre.

Following acquisition of the leases, Kerr-McGee Corporation initiated an extensive exploration program to define the physical and chemical characteristics of the coal. Projected reserves of 300 million tons of low ash, low sulfur coal under relatively shallow overburden were defined. Approximately 3,624 acres of mineable coal underlie the Jacobs Ranch Mine lease. Drilling to finally delineate location of the burn line began February 25, 1974.

Surface and coal ownership is given below:

	Surface	Coal
United States	640*	4,352
Kerr-McGee	3,712	0
Total	4,352	4,352

*Forest Service

Purpose of proposed project

Development of the Jacobs Ranch Mine is planned to meet low sulfur coal supply contract commitments. In 1973, three 20 year sales contracts and options were signed for a total of 250 million tons of coal. Purchasers include Arkansas Power and Light Company, and Gulf States Utilities. Contract commitments require a coal production schedule as follows:

Year	Million Tons
1976 (March-December)	1
1977	1.2
1978	5
1979	9.2

Under this schedule, it is planned to begin construction of surface facilities and initial mine stripping in early to mid 1975. A mining and reclamation plan for this proposed mine was submitted to the U.S. Geological Survey on December 20, 1973, and is being reviewed by the G.S., the Forest Service and the Bureau of Land Management to determine what additional stipulations will be required. The plans have also been available for public inspection in Billings, Montana at the office of the Area Mining Supervisor, U.S.G.S.

Site location

The proposed Jacobs Ranch mine to be operated by Kerr-McGee Coal Corporation is located in T43N, R69 and 70W, Campbell County, Wyoming. A description of the lands contained in federal leases W-23928 and W-24710 is shown diagramatically in Figures 1 and 2.

Gillette (population 7,194 - 1970 census), the county seat of Campbell County, is 42 miles north - northwest of the minesite, and Douglas (population 2,677 - 1970 census), the county seat of Converse County, is 65 miles south. Reno Junction, the intersection of State Highways 387 and 59, is 13 miles northwest. The small community of Hilight, 10 miles north - northwest of the minesite, is a residential settlement of mobile homes adjacent to a gas pumping station.

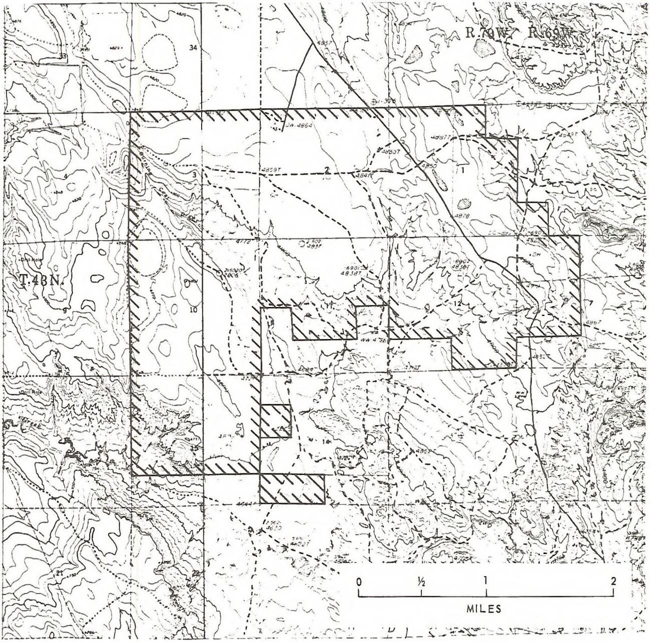


Figure 2

Location of Kerr-McGee Corporation's Federal Coal Lease W-23928

Showing Topography and Geography

Gillette is served by a main line of the Burlington Northern railroad. A spur line, the Gillette Branch, extends southward from this main line to the Belle Ayr mine, of Amax Coal Company, in T48N, R71W. Douglas is served by two main lines, the Burlington Northern railroad and the Chicago North Western Transportation Company.

The main east-west highway serving northeastern Wyoming is the partially completed Interstate Highway 90 with U.S. Highway 14-16 connecting the completed sections.

Partially completed Interstate Highway 25 is the main north-south highway through eastern Wyoming and completed sections are connected by U.S. Highway 87.

State Highway 59 is the main connecting route between Douglas and Gillette; it passes about 11 miles west of the mine site. There are several unpaved roads near the proposed mine.

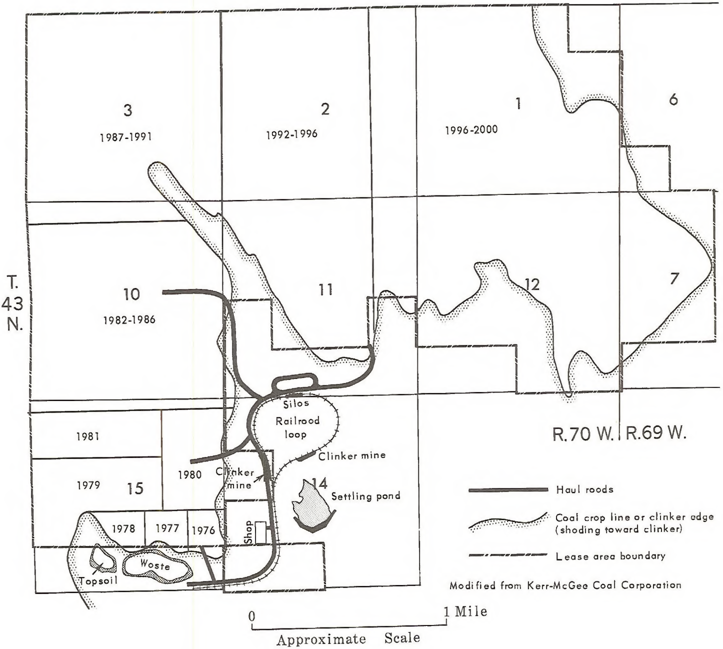


Figure 3

Kerr-McGee Corporation Proposed Jacobs Ranch Mine Plant Layout and Development Plan Using Trucks and Shovels for Overburden Removal

Stages of Implementation

The following description of mining and reclamation activities is taken, with modification, from the mining and reclamation plan submitted by Kerr-McGee Corporation.

Proposed mining procedures and equipment. Initial mining is proposed for the SE ¼ of section 15 (1976-1977) and the SE ¼ of section 11 (1978), on lease W-23928 (Figure 3). The mine areas will be opened by conventional open pit methods.

Soil material removal

Topsoil removal, storage and placement will be determined by: (1) analyses of topsoils on the leases to determine their capacity to support desired plant species: (2) amenability of other overburden materials to support revegetation efforts if the surface soils in certain areas are determined to be toxic or of poor quality: (3) the results of consultations with the County Agent, local Forest Service rangers, and other appropriate representatives of federal and state agencies: and (4) results of test plots and past reclamation efforts both on and offsite. Topsoil suitable for supporting desired vegetation will be removed from mine areas prior to stripping or construction and placed on graded spoils or in stockpiles separate from overburden. Some existing topsoils in dry lake areas are highly saline sodic or clayey and may not be suitable for revegetation.

In such cases, other overburden material that has been determined by soil analysis to be suitable for revegetation will be utilized in lieu of topsoil. Topsoils with high salinity will be buried with other overburden wastes.

Wheel-tractor scrapers will be used for removal of topsoil from the immediate areas scheduled for overburden removal and for placement of topsoil materials on disturbed areas where revegetation is planned. Scrapers may also be used for cleaning of dirt or slack coal from the surface of coal seams.

Overburden removal

Three different methods of overburden removal are currently undergoing evaluation by the company: shovel and truck system, dragline, and wheel-tractor scrapers.

The shovel and truck system (Figures 6 and 7, Chapter III, Part I) will be used for initial mine entry, and detailed plans are being made to enable the mine to be developed completely with trucks and shovels. With this method, the overburden will be removed in strips of sufficient length to allow a 1,300 foot strip of coal to be available for mining. The initial block of overburden, approximately 1,500 feet by 2,000 feet in size, will be hauled outside the mine area and permanently deposited on land underlain by no mineable coal outside the burn line (Figure 3).

As coal is mined from the block, the overburden removed by advancing the pit will be placed in the mined out area. This pattern will be continued until all economically mineable coal has been removed from the lease area. The shovel-truck method will allow selective placement of overburden and parting materials in the backfill area. Reclamation will advance as an integral part of the backfilling operation because of the continuous leveling and grading of the area where the trucks dump.

The dragline operation for overburden removal may follow the initial shovel-truck method in three to four years. Thickness of coalbeds would necessitate rehandling of approximately 35 percent of the overburden with this

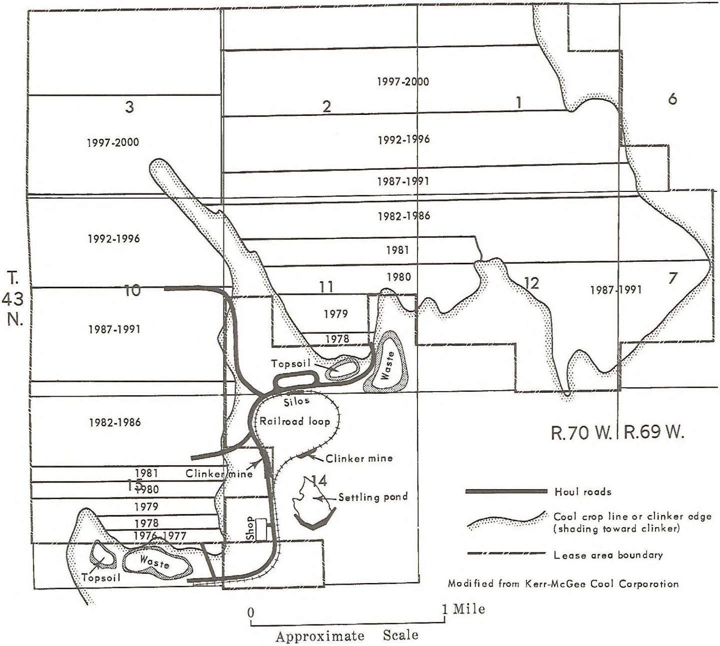


Figure 4

Proposed Alternate Mining Plan Utilizing a Dragline for Overburden Removal

method. The dragline system would strip overburden in a series of cuts 100 - 150 feet wide and approximately one mile in length. Each cut would be opened from the east and move to the west. Mining would progress from the burn line on the south toward the north lease boundary. The overburden from each cut will be placed into the mined out portion of the previous cut. Two areas may be opened for mining and operated at the same time to provide flexibility of coal production and land reclamation activities (Figure 4). Overburden and parting will probably require drilling and blasting prior to removal. All blasting will be done in accordance with applicable safety regulations.

Material from the two parting zones which separate the three coalbeds will be removed by front end loaders or shovels, and trucks or scrapers. Any overburden material determined by soil analysis to be toxic will be buried in the spoil areas. The spoil piles will be graded to conform with surrounding topography in accordance with the reclamation plan.

Clinker removed in the course of mine development will be used, when suitable, for constructing haul roads, shop area parking, and access roads. Quantities required for these purposes have not been determined. Two large clinker outcrops in Section 14 on private land will be contoured for the railroad right-of-way. A portable crushing plant will be leased or contracted to size the clinker for use as base aggregate.

Coal removal

Three continuous or nearly continuous coalbeds are found on the leases. The Uppermost bed, the Upper Wyodak, averages 8.1 feet in thickness and is separated from the middle bed by a shale and/or sandstone parting which ranges in thickness from 0 to 45 feet. The middle bed, the Lower Wyodak 1, averages about 43 feet in thickness and is separated from the lower bed by a

shale parting which ranges in thickness from 0 to 73 feet. The lowest bed, the Lower Wyodak 2, averages nearly six feet in thickness. In areas where the parting between Lower Wyodak 1 and Lower Wyodak 2 beds is thick, causing the Lower Wyodak 2 coal to be uneconomical, the parting and coal will not be mined.

After overburden has been removed, coal will be cleaned of any dirt or slack coal and will be drilled and blasted prior to loading. The uppermost bed will be loaded into trucks by either front end loader or shovel and hauled to the crushing facility. One alternative system is to mine the upper bed with a front end loader and dump it where the shovel can pick it up while mining the 43-foot thick middle bed. The lower bed will be mined with either a front end loader or shovel.

Coal will be hauled to the crushing facility where it will be crushed to a size satisfactory to the customer. It will be stored in either covered silos or open storage where it will be conveyed to the silos for loading into unit trains.

Reclamation

All reclamation work will be conducted in accordance with the provisions set forth in the federal coal leases (W-23928 and W-24710), the Wyoming Environmental Quality Act of 1973, and in agreement with the United States Geological Survey, the Bureau of Land Management and Forest Service. It is the policy of the Interior Department that all operations on leases be conducted in accordance with the most stringent laws and regulations whether federal or state. Surface disturbance as a result of mining operations will range from 100 to 150 acres per year over the projected 30 year life of the mine.

Spoil reclamation

Waste dumps south of the two initial entry areas will be rounded to conform with surrounding topography, the topsoil will be replaced, and planting will be completed as soon as backfill space is available in the pits. In the inpit spoil areas, where waste has been placed by draglines, trucks, or scrapers, several variations in the shape of spoil piles will result.

Where a dragline system is used to uncover the coal, a series of high parallel ridges 100 to 150 feet apart will result. The peaks of these ridges will be dozed or hauled into the intervening valleys resulting in a gently rolling topography. Where the shovel truck system is used, selective placement of overburden and parting material will take place and for efficient truck operations, continuous leveling and grading of the surface of the dump area will be required. The resultant topography would be more level than with the dragline system. The scraper system also allows for selective placement of overburden in fill areas and will provide the greatest degree of flexibility in creating desired land topography.

Once an area has been rough graded, topsoil will be placed by wheeled scrapers and the area will be ready for revegetation. One or two fill areas will be fine graded at a time while the fill area closest to active mining will be left untouched to avoid interfering with mining. Grading will run concurrently with the mining as the above sequence is repeated.

In disposing of the final highwall, a method will be sought by Kerr-McGee Coal Corporation which will be agreeable to the adjacent lease holders at that time and to the concerned state and federal government agencies.

Final disposal of haul roads will consist of scarifying to mix and bury the roadbed material, final regrading to a rolling shape, topsoiling, and seeding.

Drainage control

An adequate drainage system will be built into the final graded area so that runoff can be controlled and contained in a minimum of places. Catchment basins will be built where required and will serve as settling basins, evaporation ponds, and livestock watering ponds. Overflow water from the basins can be directed into natural stream channels.

To protect the mine area from collecting excess water during periods of heavy precipitation and runoff, a perimeter ditch will be established around the high sides of the active mine. These ditches will carry the water to settling ponds where the suspended material will settle. Overflow from the ponds will be directed to a natural stream channel.

All diversion ditches and dams will be constructed to the specifications shown in Figure 11, Chapter III, Part I.

Ground water that collects in the pit will be collected in sumps and pumped through pipelines to the settling pond near the railroad loop, which is shown on Figure 3. At this point the suspended material will settle out and if further treatment is necessary, the required facilities will be constructed.

Culverts will be installed under all roads or railroads to insure unrestricted flow of all water courses.

All water discharges must satisfy the requirements set forth in the Federal Water Quality Acts and the Wyoming Water Quality Standards.

Seeding and planting

The objective of the mined land reclamation program will be to return the area to its present use, which is livestock grazing. Vegetation which is selected for planting will be chosen under advisement of the County Agriculture

Extension Agent, the Bureau of Land Management, the Forest Service, and recommendations of the State of Wyoming Department of Environmental Quality.

When grading of the spoil piles has been completed and the topsoil material has been spread, soil tests will be taken to determine if and to what extent fertilizers or other nutrients are necessary to sustain plant growth. An experimental program will be instituted to determine which of the desirable legumes and grasses are most adaptable to this particular region.

Standard farm equipment will be used to prepare the soil for planting. A grain drill will be used to plant the seed and will generally follow a pattern along the contour of the land. This will tend to prevent water from forming channels and will hold soil erosion to a minimum. Seeding will be done in the fall or spring when the ground is free of frost.

Surface facilities

The location of proposed surface facilities of the Jacobs Ranch Mine is shown on Figure 3.

Roads

Access and main haulage roads will be designed to support the coal haul trucks. Grades will be restricted, where possible, to less than eight percent for efficient truck operation. Roads will be constructed using clinker from the burn areas and will be watered to minimize dust and continuously maintained by graders. Drainage ditches and culverts will be installed adjacent to and beneath the roads to allow water movement and prevent erosion and washout of the roadways.

Railroad spur

A standard gauge railroad spur and mine loop will be constructed possibly using clinker as ballast. Railroad grades will be maintained at one percent. Cross drainage beneath the roadbed will be provided by culverts. Final railroad spur location is dependent upon location of the main access spur.

Power

Electric power will be required for mine shops, electric shovels, crushing station, and loading facilities will be required. Tri-County REA will supply power through an extension of an existing 69.5 kv line near Hilight. Main service lines will bring electric power to the mine site, however, location of the power line has not been fixed, and the location of the power substation at the mine site has yet to be determined. Total power requirements for the Jacobs Ranch mine will be approximately 10 Mva.

Office and shop

Office and shop facilities will be required at the mine site but specifications as to size and type of structure have not been determined. Sewage from surface facilities will be treated in a septic tank and discharged into a drain field and sand filter bed. Waste from the office and shop facilities will be buried under spoil piles in the mine. Little burning of waste is anticipated, but if necessary, it will be done under controlled conditions.

Mining equipment

Potential mining equipment for the three mining systems under consideration for use at the Jacobs Ranch Mine include

Shovel - Truck System

Equipment	Size	Use
Electric Shovels (3)	20-30 cu.yd.	Overburden Stripping
*Electric Shovels (2)	25-35 cu.yd.	Coal Loading
End Dump Trucks (12)	120-175 tons	Overburden Hauling
*Coal Haul Trucks (8)	120-200 tons	Coal Haulage
Rubber Tired Dozers (4)	Cat 834 or Equivalent	Constuction, Shovel support, and Cleanup
*Crawler Dozers (5)	Cat D8, D9 or Equivalent	Spoil, Grading, Construction, & Coal Handling
*Rubber Tired Front End Loaders (3)	15-25 cu.yd.	Coal and Parting Handling
*Truck Mounted Pit Drills (3)	9 in. Diameter	Blast Hole Drilling
*Graders (2)	Cat 14 or Equivalent	Road Maintenance
*Wheel Tractor Scrapers (2)	24 cu.yd.	Topsoil Handling & Road Construction
*Dragline or Backhoe (1)	3 cu.yd.	Ditching
*Self Powered Water Wagon (1)	8,000 to 12,000 Gal. with Pump Discharge	Dust & Fire Control
*Fuel Truck (1)		Equipment Fueling
*Lube Truck (1)		Equipment Maintenance
*Portable Crushing Plant (1)		Clinker Production

*Equipment listed under Shovel Truck System.

Dragline System

Equipment	Size	Use
300 ft Boom Draglines (2)	55 cu.yd.	Overburden Removal
200-250 ft Boom Draglines (2)	35 cu.yd.	Overburden Removal
Rubber Tired Dozers (2)	Cat 834 or Equivalent	Construction & Cleanup

Rubber tired front end loaders may be used in place of 25 cu.yd. shovels for coal loading.

Loading equipment

Coal will be hauled from the mine to the crushing facility by 120 to 200 ton off highway trucks. Coal will be dumped directly into the crusher or will be placed in stockpiles and moved to the crusher by front end loaders. Final site location and specifications for crusher and stockpile areas remain to be established.

Storage facilities

Storage facilities for crushed coal will include outside surface storage as well as enclosed storage to feed the rail car loading system. Final determination on location, size, and capacity of storage silos and rail car loading system are dependent on final location and configuration of the railroad loop.

Crushing and processing equipment

Coal processing will entail crushing of coal to a size satisfactory to the customers. Washing or other processing will not be required. Crusher size remains to be determined along with enclosing structure. A dust collecting

system is planned for both crushing and storage facilities to meet health and safety requirements.

Mining sequence

Mining is planned to begin at the edge of the burned coal in Section 15 in 1976 and progress in a westerly direction until 1978. Mining will then be concentrated in the N ½ of Section 15 until 1981. Figure 3 shows the annual mine extensions from 1976 through 1981 and the proposed five year extension blocks after 1981. Present plans call for coal to be mined out of Section 15 by 1981, Sections 3 and 10 by 1991, and coal in Sections 1, 2, 11 and 12 by the year 2000. Additional coal purchase contracts for uncommitted reserves on the lease could accelerate this development schedule.

Stripping of overburden is planned to begin in mid 1975 at the burn line in Section 15. Coal removal using shovel-truck equipment will closely follow overburden stripping. The three coal beds will be mined over most of the lease. Overburden increases in thickness from south to north and east to west. Increasing overburden and increasing parting thickness between the Lower Wyodak 1 and Lower Wyodak 2 bed limit the area from which the Lower Wyodak 2 bed can be mined. The economic limit of mining of the lower Wyodak 2 bed is shown on Figure 6, Chapter II.

Monitoring

A variety of monitoring equipment is planned for the Jacobs Ranch mine. Five hydrologic monitoring wells are planned and should be completed in April or May, 1974. These wells will allow determinations of ground water flow, water quality, and quantity. A standard climatological station is to be located on the mine property; however, the specific site has yet to be determined. This station will allow continuous monitoring of temerature, wind velocity and

direction, and precipitation, and it may be equipped to determine dust concentrations, and barometric readings.

Coal sampling and weighing equipment will be installed at the rail loading facility to maintain average quality of the shipped product and accurate weights for royalty payments and customer billings. A rail scale will be installed after the loading silos to permit in-motion weighing of unit trains. The scale will be equipped for unattended automatic operation. An automatic car identification system with calendar clock will also be installed. It is also anticipated that a belt scale will be installed to check daily production.

A laboratory will be constructed and equipped to analyze for Btu, moisture, ash, sulfur and volatile matter, both for pit control and unit train shipments.

Monitoring of surface water quality is planned for the settling ponds prior to discharge of water to local drainages. If water treatment is necessary, a continuous monitoring system controlling automatic treatment equipment may be installed or settling ponds may be converted to evaporation ponds for water disposal.

Such additional monitoring equipment as may be required to maintain environmental quality will be installed as conditions warrant.

Transportation and marketing

Coal from the Jacobs Ranch mine will be loaded into 120 to 200 ton off highway trucks and hauled to the crushing and train loading facility over main haul roads. The rail loading complex is located on the mine loop on a spur of the Burlington Northern railroad.

Coal will leave the mine via trains to the main line of the Burlington Northern or Chicago North Western for shipment to the purchaser's power plants in Arkansas and Louisiana. Additional purchase contract commitments may be made

for remaining coal reserves. Transportation to additional markets would most likely be via railroad.

Utilization

Some 300 million tons of strippable coal reserves have been identified on the Jacobs Ranch mine leases. Of this reserve, 250 million tons have been committed by sales contracts and options to three utility companies for electrical power generation. The remaining 50 million tons of coal is uncommitted at present, however, additional coal sales contracts are being sought by Kerr-McGee Corporation.

Arkansas Power and Light Company has signed a purchase contract for 100 million tons of coal to be delivered over a 20 year period beginning in July, 1977. This power company holds a 10 year option for the purchase of an additional 50 million tons of coal. Arkansas Power and Light plans to use the coal at its electrical generating station to be constructed near Redfield, Arkansas. Construction of the first 700 megawatt (MW) generating unit is scheduled to begin in November, 1974. Planned capacity of this station is two 700 MW generating units.

Central Louisiana Electric Company has signed a purchase agreement for 34 million tons of coal to be delivered over a 20 year period beginning in July, 1978, and it holds a 10 year option for the purchase of an additional 16 million tons of coal. Central Louisiana Electric Company plans to use the coal for electric power generation at its Boyce, Louisiana generating station which is currently under construction. This station has a planned generating capacity of 450 MW from a single generating unit.

Gulf States Utilities has signed a purchase contract for 50 million tons of coal to be delivered over a 20 year period beginning in March, 1977. Options

for additional coal are not held as part of the coal sales contract. Gulf States Utilities plans to use the coal for electric power generation at a power plant to be constructed in the Lake Charles area of Louisiana. This power plant is to house two 550 MW generating units.

A total of 184 million tons of coal is committed to direct sales contracts with an additional 66 million tons held on option.

CHAPTER II

DESCRIPTION OF THE EXISTING ENVIRONMENT

Air Quality

Air quality over the lease is similar to that described in Chapter IV, Part I.

Climate

Description

The description of general climate, temperature, and precipitation data in Chapter IV, Part I adequately characterizes the climate on the Kerr-McGee lease.

In 1970 an unofficial precipitation gauge on a ranch three miles from the Kerr-McGee lease measured six inches of precipitation (rain) in 12 hours. The accuracy of this measurement is unknown. No frequency can be assigned to the event.

Studies conducted of microclimate are usually below the 4.5-foot level where standard weather stations are located. There are no known studies of microclimate on the Kerr-McGee lease. The most drastic effect on climate due to surface mining will occur in the microclimate. Changes in the microclimate may be the limiting factor in achieving revegetation.

Topography

The Jacobs Ranch mine in southeastern Campbell County, Wyoming, is located on the eastern edge of the rolling upland formed on the Wasatch Formation. The upland is part of a stripped structural surface forming a plateau that extends from Gillette to the Cheyenne River. Along the eastern and southern sides of the lease site, deeply dissected areas of clinker, typical of the burnline, separate the upland from the adjacent cliff-forming massive sandstone of the Fort Union Formation. These cliffs form an irregular escarpment known as the Rochelle Hills.

The coal lease and adjoining area contain the following landforms: rolling upland, rough hummocks of the burnline, ridges and knobs, gullied shale slopes, alluvial terraces, and small floodplains. About 70 percent of the lease is rolling upland (Figure 1). This upland consists principally of shale and sandstone of the Wasatch Formation. Playas in scattered depressions occur on the plateau. These intermittent lakes, varying in size from less than a few yards to almost one-half mile in diameter, may be caused by subsidence of strata over locally burned coal. The remainder of the lease area is either the shale slope or alluvial terrace.

A zone of rough broken land, deeply dissected by gulleys, borders the plateau. Hummocky clinker and fractured outcrop make up the rough land. The areal extent of baked or fused clay and sand deposits, above and below the burned coalbeds, is undefined. These resistant clinker beds retard erosion of the underlying sandstone and form knobs and ridges east of the burnline. Below the steep wooded breaks, the slopes flatten into flat coalescing alluvial terraces.

Floodplains fill part of the valleys adjacent to the lease area. Most runoff from the mine site drains into the North Fork of the Little Thunder Creek which is a tributary of the Cheyenne River. The remainder enters the Big Thunder Creek also tributary to the Cheyenne. Like many watercourses in arid and semiarid climates, flow is mainly intermittent. These streams flow during heavy runoff, but most water disappears into the streambeds leaving only isolated pools.

The maximum altitude on the lease is about 4,900 feet in the northeast part; the minimum altitude is 4,635 feet in the North Prong of Little Thunder Creek (Section 15). Average relief is over 200 feet.

Slopes on the upland areas are usually less than 5 percent, whereas the deeply eroded areas have slopes as steep as 40 percent. These slopes flatten at the alluvial terraces from 5 to 10 percent.

Figure 1

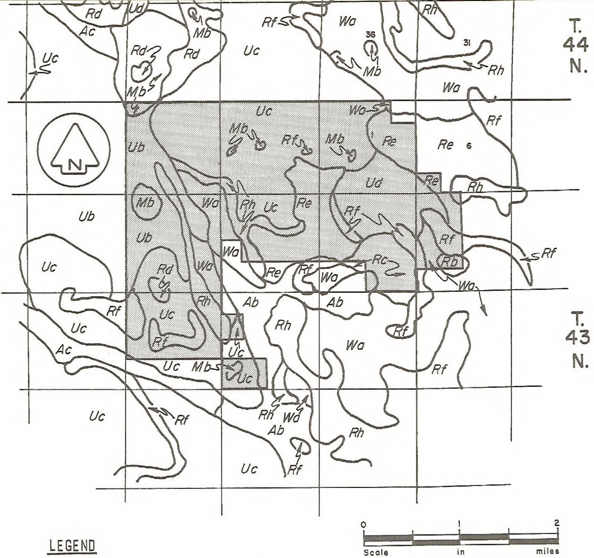
Existing Topography in the Area of the Proposed Ranch Mine

Soils

Soil data for the Kerr-McGee lease was taken from the Campbell County Reconnaissance Soil Survey. The field work was completed in 1939 and published by the USDA-Soil Conservation Service in 1955. This survey is very general (reconnaissance) although a number of series were identified. Each delineation includes several other soil series or variations not mapped or mentioned due to minor amounts or the failure of identification according to modern concepts. Since the end of the field work on this survey, major classification methods have passed through the Great Soil Group system (1938), the 7th Approximation (1964) and currently the New Soil Taxonomy (1971). Soils identified and classified in 1939 bearing the same series name of today may not approach similarity. Interpretations are based on modern concepts of the series identified offsite. Therefore, the implied interpretations may be somewhat less desirable than the basic interpretation of 1939. Soils of the area have not changed significantly since 1939 but technology in the field of soil science has. Detailed soil inventories must be conducted on the lease area and adjacent lands in order to properly evaluate impacts on the land and the relationships to the existing environment.

A soil map showing the distribution of soil units within the lease is illustrated in Figure 2. Interpretations of the soil units are summarized in Table 1. Detail interpretations of each soil unit are in Tables 10 through 28 in Appendix C.

The following soil unit descriptions provide definition to the generalized distribution of soils on Figure 2.



LEGEND

- Ab — Arvada Clay Loam
- Mb — McKenzie Clay
- Rb — Renohill Clay Loam
- Rc — Renohill Clay Loam, Rolling Phase
- Rd — Renohill Loam
- Re — Renohill Loam, Rolling Phase
- Rf — Rough Broken Land
- Rh — Rough Broken Land (Searing Soil Material)
- Ub — Ulm Clay Loam, Shallow Phase
- Uc — Ulm Loam
- Ud — Ulm Loam, Reddish Subsoil
- Wa — Wibaux-Searing Complex Phase
- Boundary of Kerr-McGee Coal Property

Figure: 2 General soils map (Kerr-McGee Coal Property)

SOIL UNIT		EROSION HAZARD POTENTIAL 2/		REVEGETATION POTENTIAL	SUITABILITY FOR SPRINKLER IRRIGATION	SUITABILITY FOR FINAL COVER FOR MINED LAND		SUITABILITY FOR TRANSPORTATION ROUTES	SUITABILITY FOR ROADFILL	SUITABILITY FOR SANITRAY FACILITIES			SUITABILITY FOR SMALL COMMERCIAL BLDGS.
Symbol	%Slope	Water	Wind			In. Available	Suitability			Septic-tank Absorption Fields	Sewage Lagoons	Sanitary Landfills (Trench)	
Ab	0-5	M	M	L	L	0	L	L	L	L	L	L	L
	5-10	H	M	L	L	0	L	L	L	L	M	L	L
Mb	0-5	M	M	L	L	0	L	L	L	L	L	L	L
Rb	0-5	M	M	M	L	6	M	L	L	L	L	L	L
	5-10	H	M	M	L	6	M	L	L	L	L	L	L
Rc	10-20	H	L	M	L	6	M	L	L	L	L	L	L
	20-30	H	L	M	L	6	M	L	L	L	L	L	L
	30-40	H	L	M	L	6	M	L	L	L	L	L	L
Rd	0-5	M	M	M	M	8	H	L	L	L	L	L	L
	5-15	H	M	M	M	8	H	L	L	L	L	L	L
Re	10-20	H	L	M	M	8	H	L	L	L	L	L	L
	20-30	H	L	M	L	8	H	L	L	L	L	L	L
	30-40	H	L	M	L	8	H	L	L	L	L	L	L
Rf	20-30	H	L	L	L	0	L	L	M	L	L	L	L
	30-40	H	L	L	L	0	L	L	L	L	L	L	L
	40-50	H	L	L	L	0	L	L	L	L	L	L	L
Rh	20-30	H	L	L	L	0	L	L	M	L	L	L	L
	30-40	H	L	L	L	0	L	L	L	L	L	L	L
	40-50	H	L	L	L	0	L	L	L	L	L	L	L
Ub	0-5	M	M	L	L	6	M	L	L	L	L	L	M
	5-10	H	M	L	L	6	M	L	L	L	L	L	M
Uc	0-5	M	M	M	M	16	M	M	M	L	L	L	M
	5-10	H	M	M	M	16	M	M	M	L	L	L	M
Ud	0-5	M	M	M	M	16	H	M	M	L	L	L	M
	5-10	H	M	M	M	16	H	M	M	L	L	L	M
Wa	5-10	H	L	L	L	8	L	M	H	L	L	L	H
	10-20	H	L	L	L	8	L	L	H	L	L	L	M
	20-30	H	L	L	L	8	L	L	M	L	L	L	L

1/ - 3 Classes - L - Low, M - Moderate, H - High.

2/ - Estimated on-site erosion, bare soil conditions, L - <3.T./ac, M - 3-8 T./ac., H - >8T./ac.
Source of interpretations: 1. Descriptions from Cambell County. 2. Soil Conservation Service soil profile descriptions. 3. S.C.S. Form 5, Interpretation sheet. 4. Region 2, F.S. Guidelines for Soil Interpretations. 5. S.C.S. Guide for Interpreting Eng. Uses of soils.

Table 1
Kerr-McGee
Soil Interpretation Summary 1/

Ab-Arvada clay loam.

Arvada clay loam occupies sloping terraces and alluvial fans that have been formed by local alluvium from upland soils. The soil has alkali or saline areas and bare spots where wind erosion has removed the surface and exposed the clay subsoil.

The surface horizon is light brownish gray friable clay loam about four inches thick. The soil reaction (pH) ranges from slightly to strongly alkaline. The subsoil is brown to gray clay to clay loam about 20 inches thick and has columnar to prismatic structure. The substratum is clay loam to clay to 60 inches or more. The soil reaction of the subsoil and substratum ranges from strongly to very strongly alkaline. The internal drainage is very slow. The exchangeable sodium percentage of the subsoil and substratum is high, more than 15 percent. There are an estimated 50 acres of these soils on the lease.

Mb-McKenzie Clay.

McKenzie clay occurs in shallow, intermittent lakes on upland landforms. The soil consists of gray or dark gray clay materials which have eroded from upland soils. McKenzie clay varies in stage of development as carbonate bearing layers may occur a few inches to several feet below the surface.

The surface layer is 2-5 inches thick and ranges from sandy loam to clay. The substratum is dominantly a massive gray clay and may be more than 60 inches deep. Soil reaction is normally strongly to very strongly alkaline. Carbonate content is variable but usually increases with depth. Internal drainage is very slow. Saline and sodic salts are present in some locations. There are an estimated 140 acres of these soils on the lease.

Rb-Renohill clay loam.

Renohill clay loam occupies gently sloping to rolling uplands. The parent material is weathered shale of the Wasatch, Lance, and Fort Union Formations. The clay loam surface horizon is 3 to 6 inches thick and has granular structure. The upper subsoil is clay to clay loam with prismatic and blocky structure. It normally contains no free clacium carbonate. The lower subsoil is clay loam and contains calcium carbonate. The clay loam substratum is calcareous extending to bedrock which occurs at depths of 20 to 40 inches. Soil reaction is normally neutral to moderately alkaline. The depth to calcareous material ranges from 6 to 20 inches. Internal drainage is slow. There are an estimated 50 acres of these soils on the lease.

Rc-Renohill clay loam, rolling phase.

This rolling phase differs from Renohill clay loam in topography, depth of soil, and degree of erosion. The topography is rolling to steep. The depth to bedrock ranges from less than 10 inches to 40 inches. Bedrock is exposed on some of the steeper slopes. Natural erosion has formed gullies in some areas. The parent material is weathered shale of the Lance, Wasatch, and Fort Union Formations. The clay loam surface layer is generally 3 to 6 inches thick and has granular structure. The subsoil and substratum are clay loam to clay with carbonates at depths of 6 to 20 inches. Soil reaction is normally neutral to moderately alkaline. Internal drainage is slow. There are an estimated 150 acres of these soils on the lease.

Rd-Renohill loam.

Renohill loam occupies gently sloping to rolling uplands. The parent material is weathered shale of the Lance, Wasatch, and Fort Union Formations.

The loam to sandy loam surface horizon is 3 to 8 inches thick. The upper subsoil is clay loam to clay with prismatic and blocky structure. It normally contains no free calcium carbonate. The lower subsoil is clay loam and contains calcium carbonate. The clay loam substratum is calcareous extending to bedrock which occurs at depths of 20 to 40 inches. Soil reaction is usually neutral to moderately alkaline. The depth of calcareous material ranges from 6 to 20 inches. Internal drainage is slow. There are an estimated 40 acres of these soils on the lease.

Re-Renohill loam, rolling phase.

This rolling phase differs from Renohill loam in topography, depth of soil, and degree of erosion. The topography is rolling to steep. The depth to bedrock ranges from less than 10 inches to 40 inches. Bedrock is exposed on some of the steeper slopes. Natural erosion has formed gullies in some areas. The parent material is weathered shale of the Wasatch, Lance, and Fort Union Formations. The loam to sandy loam surface layer is usually 3 to 6 inches thick. The upper subsoil is clay loam to clay with blocky and prismatic structure. It normally contains no free calcium carbonate. The lower subsoil is clay loam and contains calcium carbonate. The clay loam substratum is calcareous. Soil reaction is normally neutral to moderately alkaline. The depth to calcareous material ranges from 6 to 20 inches. Internal drainage is slow. There are an estimated 480 acres of these soils on the lease.

Rf-Rough broken land.

Rough broken land consists of steep, eroded, strongly dissected areas along escarpments, steepwalled drainage channels, and rock outcrops. The parent material is interbedded shale, sandstone, and limestone. Small areas of shallow

to deep soils are intermingled in rough broken land. The density of vegetation is quite variable ranging from bare areas or sparse vegetation on rock outcrops to dense stands on the deeper soils. The physical and chemical properties of the unit are very variable. There is an estimated 280 acres of this land type on the lease.

Rh-Rough broken land, searing soil material.

This unit is a complex of rough broken land and eroded areas of clinker. Rough broken land includes steep, eroded, strongly dissected areas along escarpments, steep-walled drainage channels, and rock outcrops. Clinker is a red or reddish colored shaly material produced by the heating and partial fusing of clays during the burning of underlying coalbeds. Searing soil is characterized by a reddish brown gravelly loam surface about five inches thick. The subsoil is a gravelly clay loam to loam which has blocky structure. The substratum is a friable, calcareous gravelly loam. Bedrock generally occurs at a depth of two feet. This unit has fragments and blocks of red shale, stone, and clinker scattered on the surface. Internal drainage is good. There is an estimated 290 acres of this land type on the lease.

Ub-Ulm clay loam, shallow phase.

This phase differs from Ulm loam in topography, texture, and depth of soil. The topography is rolling, and the depth to interbedded sedimentary bedrock ranges from 10 to 20 inches. The steeper slopes have some rock outcrops. The surface horizon is granular clay loam about six inches thick. The subsoil is calcareous silty clay loam with prismatic structure. The subsoil normally becomes more loamy and friable with depth. Internal drainage is moderate to

slow. Soil reaction normally ranges from neutral to moderately alkaline. There are an estimated 540 acres of these soils on the lease.

Uc-Ulm loam.

Ulm loam occupies gently sloping to rolling uplands. The parent material is interbedded sandstone, shale, and limestone. The surface horizon is friable loam 3 to 7 inches thick. The subsoil ranges from sandy clay loam to clay loam and has prismatic structure. The calcareous substratum ranges from sandy loam to clay loam and extends to weathered bedrock at depths of 20 to 40 inches. Soil reaction normally ranges from neutral to moderately alkaline. Internal drainage is good. There are an estimated 1,702 acres of these soils on the lease.

Ud-Ulm loam, reddish subsoil phase.

This phase occupies gently sloping to rolling uplands. It is developing in material weathering from brownish-red or light red sandy shale. The surface horizon is friable loam to sandy loam six inches thick. The reddish brown clay loam subsoil has blocky structure. The calcareous to neutral substratum ranges in texture from clay loam to sandy loam. The shaly parent material occurs at depths of 20 to 30 inches. Fragments of clinker are present on the surface and in the soil profile in most places. Soil reaction normally ranges from neutral to moderately alkaline. Internal drainage is good. There are an estimated 430 acres of these soils on the lease.

Wa-Wibaux - Searing Complex

This complex occupies rolling to hilly topography. It is characterized by numerous outcroppings or knolls of clinker which rise above the general surface of the land. The very shallow to shallow Wibaux soils occur on the knolls and steep slopes. It includes knolls, mounds, and steep slopes where unweathered

clinker is exposed. The texture is gravelly to very gravelly loam and sandy loam. The depth to bedrock is less than 10 inches to 20 inches.

Searing soil normally occurs between the knolls. The surface horizon is reddish brown gravelly loam about five inches thick. The subsoil is a reddish brown gravelly clay loam and has blocky structure. The substratum is friable, calcareous gravelly loam. Bedrock generally occurs at an average depth of two feet. There are an estimated 200 acres of these soils on the lease.

Mineral Resources

Stratigraphic and structural relations

The Kerr-McGee Coal Corporation's federal coal leases in T43N,R69 and 70W are on the gently dipping eastern flank of the Powder River Basin (Figure 10 Chapter IV, Part I). This broad regional downwarp, or asymetrical structural basin, contains nearly flat-lying rocks of Tertiary age in the center surrounded by Cretaceous and progressively older rocks that are upturned on the flanks of the bounding Precambrian-cored mountains--the Black Hills to the east, the Bighorn's to the west, and the Laramie Range to the south (Figure 11, Chapter IV, Part I). Northward, the basin indistinctly blends into the Great Plains.

The leases are in the Gillette coal field that was mapped by Dobbin and Barnett (U.S. Geological Survey 1927). The following descriptions of the geology and coal are summarized from their report, the reports cited in Part I of this statement, and the material submitted in the mining and reclamation plans by Kerr-McGee Coal Corporation. The lease area is on the boundary between the Fort Union Formation of Paleocene age and the overlying Wasatch Formation of Eocene age. The contact is drawn at the top of the Wyodak coalbed; however, the coalbed is not usually exposed because at most places it is masked by alluvium or by the red baked and fused rock, formed when the coal burned along the crop line sometime in the past.

The Tongue River Member of the Fort Union Formation as mapped by Dobbin and Barnett is the oldest rock sequence exposed on the lease area. It is underlain in turn by the Lebo and Tullock Members, and then by the Cretaceous Lance Formation and Fox Hills Sandstone to a depth of about 3,000 feet. Increasingly older sedimentary formations representing Mesozoic and Paleozoic ages lie below the Fox Hills Sandstone to a depth of about 14,000 feet below

the surface where the top of the Precambrian igneous and metamorphic rock complex is located.

The upper part of the Fort Union Formation is the bedrock in the eastern and southern parts of the lease area. The rocks, other than coal, are predominantly bluish-gray, brown, and dark gray carbonaceous shale (65 percent) and light gray to yellowish-gray friable sandstone (35 percent). Beds of highly ferruginous brown sandstone and hard brown sandstone concretions are common features in the member. The coalbeds range in thickness from a few feet to as much as 64 feet on the lease area. The following stratigraphic section located a few miles southeast of the proposed Jacobs Ranch mine site was reported by Dobbin and Barnett (U.S. Geological Survey 1927, p. 10).

Section of part of the Tongue River Member of the Fort Union Formation, between sec 21, T43N, R69W, and Little Thunder Creek in sec 34:

	Ft.	In.
Clinker of Wyodak (Roland) coalbed (top of Tongue River Member). (Bed is as much as 75 feet thick on the Atlantic Richfield lease area.)		
Shale, blue-gray, sandy	10	
Shale, carbonaceous, containing fossil leaves	6	
Coal		5
Shale, carbonaceous, and bone	1	9
Shale, blue-gray, carbonaceous	10	
Sandstone, gray, friable, with hard brown sandstone concretions containing fossil leaves	5	
Shale, carbonaceous	1	4
Shale, sandy, and sandstone, friable, with hard sandstone concretions	33	
Shale, dark, carbonaceous	9	
Shale, gray, sandy	7	
concretionary band at top	15	
Shale, dark bluish gray, sandy, with a few hard brown sandstone concretions	16	
Sandstone, yellowish gray, friable, with a few bands of carbonaceous shale	38	
Shale, dark blue, with fossil leaves and with selenite crystals in upper part	7	
Shale, brown, carbonaceous, with fossil leaves and fragments of conifers		10
Shale, dark blue	1	2
Shale, bluish gray, with brown sandstone concretions	12	6
Sandstone, yellowish gray, friable		11
Shale, bluish gray		8
Shale, brown to black, with lenses of bright coal in upper part		2
Sandstone, yellowish, friable	6	
Shale, blue, with 1-foot lens of black carbonaceous shale near the middle	11	
Clay, yellow, sandy, with brown sandstone concretions near the base	5	
Shale, bluish gray	11	
Shale, brown, carbonaceous	10	
Concealed	6	
Sandstone, gray, friable, with 1-foot brown concretionary band at top	8	10
Largely covered but sandstone and shale exposed in places	108	
	341	7

The remaining uneroded part of the Wasatch Formation (the overburden to be stripped at the proposed Jacobs Ranch mine) ranges from 20 feet thick in section 15 at the south edge of the lease to 168 feet thick at the northeastern corner of the property (Figures 3 and 4). Where it has not been altered to clinker in the lease area, the formation consists of about 80 percent gray, soft shale in beds 10 to 50 feet thick, about 15 percent grayish white sandstone in beds as much as 10 feet thick, and 5 percent gray siltstone or sandy shale in beds usually less than 10 feet thick. A generalized stratigraphic section is reported in the following driller's log:

	Thickness in feet
Soil and alluvium	10
Shale, gray and tan	10
Siltstone, gray (fine-grained shale)	10
Shale, gray, soft	10
Sandstone, gray	10
Shale, gray, soft (base of Wasatch Formation)	50
Coal	10
Shale, gray, carbonaceous	10
Sandstone	20
Shale, gray, soft	30
Coal	50

Samples of the Wasatch Formation from a drill hole were analyzed by Agricultural Consultants Laboratory for soil characteristics and available nutrients that should be considered during the post mining reclamation. Results are shown in Tables 2 and 3.

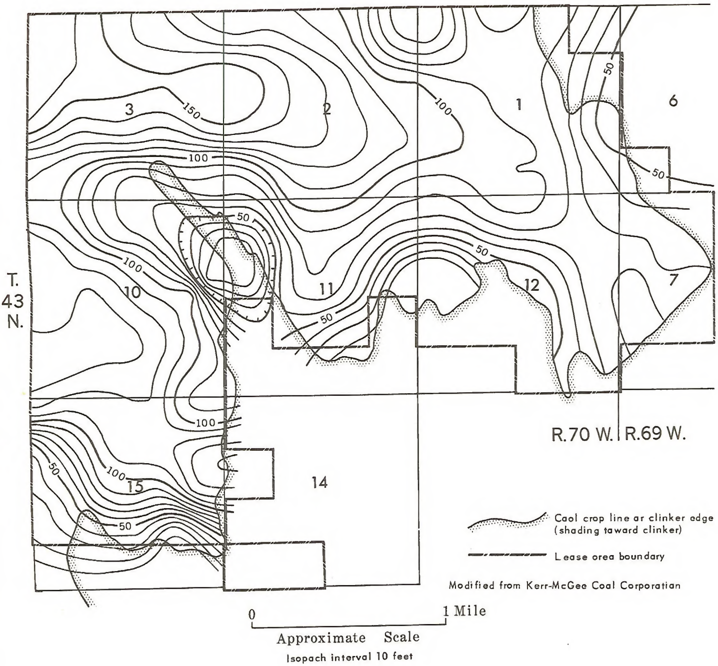


Figure 3

Thickness, in Feet, of the Overburden on the Upper Wyodak Coalbed at the Proposed Jacobs Ranch Mine, Campbell County, Wyoming

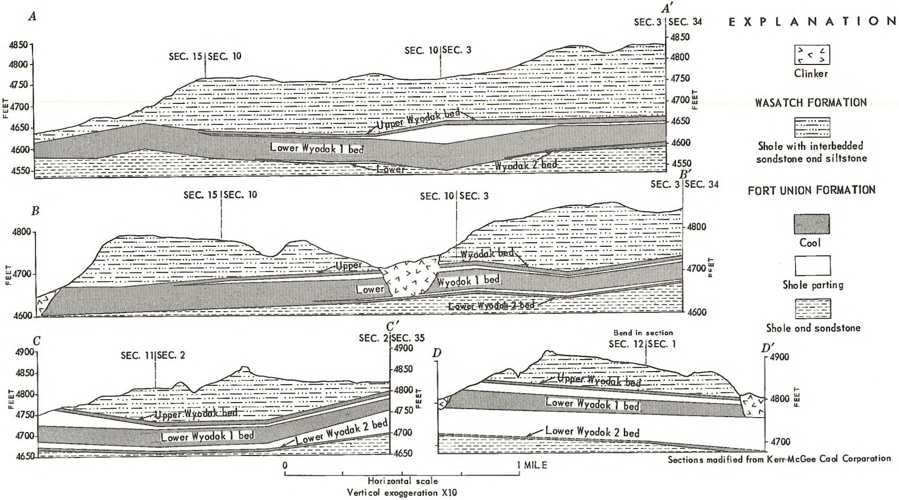


Figure 4

Cross Sections Showing Relationships of Coalbeds at the Propsed Jacobs Ranch Mine, T43N, R69 and 70W, Campbell County, Wyoming

Table 2

Soil Characteristics and Avaliable Nutrients in Samples of the Wasatch Formation from Drill Hole 3C-15 at the Proposed Jacobs Ranch Mine, Campbell County, Wyoming

DEPTH OF SAMPLE (feet)	TEXTURE si=silty sn=sandy lo=loam cl=clay	pH		CEC Meq /100g	SALT Mmhos /cm	Na Meq /100g	Lime %	OM %	Org N Lbs	AVAILABLE NUTRIENTS (parts per million)											
		H_2O	Salt							NO_3	NH_4	P(2)	K(2)	Ca	Mg	S(2)	B	Zn	Fe	Mn	Cu
0-12*	Sn Lo	8.3	7.8	11	1.3	0.3	0.1	0.4	18	6.0	0.1	2.0	56	1500	220	13	0.2	0.3	1.2	0.6	0.3
12	Sn Lo	8.3	7.8	11	1.3	0.5	0.1	0.4	16	7.0	0.1	1.0	58	1500	260	20	0.2	0.3	1.0	0.8	0.3
14	Sn Lo	8.3	7.8	12	1.3	0.8	0.2	0.3	14	7.0	0.1	1.0	62	1400	300	31	0.2	0.2	0.7	1.0	0.3
16	Sn Lo	8.3	7.8	12	1.3	0.8	0.2	0.3	14	7.0	0.1	1.0	68	1500	320	34	0.2	0.2	0.8	0.8	0.3
18	Sn Lo	8.3	7.8	13	1.3	0.9	0.2	0.3	14	7.0	0.1	1.0	73	1600	340	39	0.2	0.2	0.9	0.7	0.3
20	Sn Lo	8.2	7.7	14	1.3	1.0	0.2	0.4	18	6.0	0.1	1.0	86	1600	360	43	0.2	0.2	1.0	0.6	0.3
22	Sn Lo	8.2	7.7	14	1.3	1.0	0.2	0.4	18	6.0	0.1	1.0	97	1700	370	47	0.2	0.2	1.1	0.5	0.3
24	Sn Lo	8.2	7.7	14	1.3	1.0	0.2	0.4	18	6.0	0.1	1.0	98	1700	390	80	0.2	0.3	1.2	0.5	0.3
26	Sn Lo	8.2	7.7	14	1.3	1.0	0.2	0.4	18	6.0	0.1	1.0	97	1700	400	100	0.2	0.5	1.3	0.6	0.3
28	Sn Lo	8.2	7.6	15	1.3	0.8	0.2	0.4	18	6.0	0.1	1.0	98	1800	400	100	0.2	0.6	1.5	0.7	0.4
30	Sn Lo	8.2	7.7	15	1.3	0.9	0.2	0.4	18	6.0	0.1	1.0	96	1800	430	120	0.2	0.6	1.5	0.7	0.4
32	Sn Lo	8.2	7.7	15	1.3	0.9	0.2	0.4	18	6.0	0.1	1.0	97	1800	410	110	0.2	0.6	1.5	0.7	0.4
34	Sn Lo	8.2	7.6	16	1.3	0.8	0.2	0.4	18	6.0	0.1	1.0	98	1800	450	140	0.2	0.6	1.7	0.7	0.4
36	Sn Lo	8.2	7.7	16	1.4	0.9	0.3	0.5	22	8.0	0.2	1.0	100	1900	470	160	0.3	0.5	1.8	0.6	0.4
38	Sn Lo	8.2	7.7	16	1.5	0.8	0.3	0.6	27	10.0	0.3	1.0	110	1900	500	180	0.3	0.5	2.0	0.6	0.4
40	Sn Lo	8.2	7.7	17	1.4	0.9	0.7	0.6	27	13.0	0.3	1.0	120	2100	600	200	0.3	0.7	2.0	0.8	0.4
42	Sn Lo	8.3	7.7	24	1.3	0.9	1.1	0.6	27	15.0	0.4	1.0	130	2700	720	200+	0.3	0.9	1.9	2.3	0.7
44	Si Cl Lo	8.4	7.8	26	1.2	1.0	1.5	0.6	27	18.0	0.5	1.0	150	3200	840	200+	0.3	1.2	1.8	3.6	0.8
46	Si Cl Lo	8.4	7.8	32	1.1	1.0	1.8	0.6	24	22.0	0.7	1.0	180	3600	1000	200+	0.3	1.5	1.6	12.0	0.9
48	Si Cl Lo	8.4	7.8	32	1.0	1.0	1.6	0.5	16	20.0	0.6	1.0	190	3600	1000	200+	0.3	1.9	1.5	8.3	0.9
50	Si Cl Lo	8.4	7.8	32	0.9	1.1	1.4	0.5	16	16.0	0.5	1.0	200	3600	1000	200+	0.2	2.3	1.4	6.9	0.9
52	Si Cl	8.5	7.8	32	0.7	1.2	1.0	0.4	14	14.0	0.3	2.0	220	3400	1000	200+	0.1	10.0	1.2	6.2	1.0
54	Si Cl	8.5	7.8	31	0.7	1.2	2.1	0.6	18	12.0	0.3	2.0	220	3100	1000	200+	0.1	8.1	2.1	6.0	1.1
55.5	Cl	8.6	7.9	30	0.6	1.1	3.2	0.8	26	10.0	0.4	1.0	220	2900	1000	200+	0.1	6.3	3.2	6.1	1.2
57.5	Sn Cl	8.6	7.9	27	0.6	1.1	5.0	1.1	39	9.0	0.5	1.0	220	2700	1000	200+	0.1	2.9	9.3	5.7	1.4
59.5	Sn Cl	8.6	7.9	26	0.6	1.1	4.7	1.0	36	8.0	0.4	1.0	210	2700	1000	200+	0.1	2.7	10.0	5.8	1.4
61.5	Sn Cl	8.5	7.8	25	0.6	1.1	4.4	0.8	32	8.0	0.4	1.0	200	2600	1000	200+	0.1	2.4	11.0	6.1	1.3
64.5	2	8.6	8.0	25	0.6	1.1	3.1	1.0	40	9.0	0.3	1.0	200	2500	1000	200+	0.1	3.0	10.0	5.8	1.1
66.5	2	8.5	7.9	26	0.6	1.1	3.3	1.2	48	9.0	0.2	1.0	200	2500	1000	200+	0.1	3.1	11.0	5.7	1.1
68.5	2	8.6	8.0	25	0.6	1.1	3.6	1.3	50	8.0	0.2	1.0	200	2500	1000	200+	0.1	3.1	11.0	5.7	1.2
70.5	2	8.6	8.1	26	0.5	1.0	4.1	1.4	56	9.0	0.2	1.0	200	2500	1000	200+	0.1	3.6	8.1	5.5	1.0
72.5	2	8.4	7.9	25	0.6	1.0	4.9	1.6	64	8.0	0.2	1.0	190	2400	1000	200+	0.1	2.9	9.3	5.8	1.1
74.5	2	8.5	8.0	26	0.6	1.1	5.2	1.8	71	8.0	0.2	1.0	190	2400	1000	200+	0.1	2.9	9.6	5.6	1.2
76.5	2	8.5	8.0	26	0.6	1.1	5.0	2.1	82	8.0	0.1	1.0	190	2400	1000	200+	0.1	2.8	10.0	5.4	1.2
78.5	2	8.6	8.0	26	0.7	1.1	4.6	2.0	80	7.0	0.1	1.0	200	2500	1000	200+	0.1	2.8	11.0	5.6	1.2
80.5	2	8.4	7.9	27	0.6	1.1	4.1	2.1	80	8.0	0.1	1.0	210	2500	1000	200+	0.1	2.9	11.0	5.6	1.1
82.5	2	8.4	7.9	27	0.6	1.0	3.9	2.2	86	7.0	0.1	1.0	210	2400	1000	200+	0.1	3.0	12.0	5.6	1.1
84.5	2	8.5	8.0	27	0.6	0.9	4.3	2.1	84	7.0	0.1	1.0	210	2400	1000	200+	0.1	3.0	12.0	5.3	1.0
86.5	2	8.5	8.0	25	0.5	1.1	5.1	2.2	88	8.0	0.1	1.0	210	2400	1000	200+	0.1	3.1	12.0	5.2	1.1
88.5	2	8.5	8.0	26	0.6	1.1	5.5	2.4	96	8.0	0.1	1.0	220	2500	1000	200+	0.1	3.2	12.0	5.3	1.0
90.5	2	8.5	8.0	26	0.6	1.1	4.9	2.6	100	7.0	0.1	1.0	210	2400	1000	200+	0.1	3.4	10.0	5.4	1.1
92.5	2	8.5	8.0	25	0.7	1.1	4.7	3.0	110	7.0	0.1	1.0	210	2400	1000	200+	0.1	3.5	11.0	5.9	1.2
94.5	2	8.6	8.1	24	0.6	1.0	4.8	3.2	120	7.0	0.1	1.0	210	2400	1000	200+	0.1	3.3	11.0	6.1	1.1
96.5	2	8.6	8.0	24	0.6	1.1	5.0	4.8	120	7.0	0.1	1.0	210	2500	1000	200+	0.1	3.3	12.0	6.3	1.1
98.5	2	8.5	8.0	25	0.6	1.1	5.2	5.4	120	7.0	0.1	1.0	210	2400	1000	200+	0.1	3.1	11.0	6.1	1.0
100.5	2	8.5	8.0	25	0.5	1.1	5.2	6.3	120	7.0	0.1	1.0	220	2400	1000	200+	0.1	2.9	12.0	5.9	1.1
102.5	2	8.4	7.9	26	0.6	1.0	5.2	6.8	120	6.0	0.1	1.0	220	2400	1000	200+	0.1	2.9	10.0	5.6	1.1
104.5	2	8.4	7.9	25	0.5	0.9	5.1	7.2	120	6.0	0.1	1.0	210	2500	1000	200+	0.1	2.9	10.0	5.8	1.2
106.5	2	8.5	8.0	24	0.6	1.0	4.9	8.6	120	6.0	0.1	1.0	210	2400	1000	200+	0.1	3.1	12.0	5.6	1.2
108.5	2	8.5	8.0	24	0.5	1.1	5.0	9.0	120	7.0	0.1	1.0	210	2500	1000	200+	0.1	3.1	11.0	5.7	1.2
110.5	2	8.5	8.0	23	0.6	1.2	5.1	11.0	120	6.0	0.1	1.0	200	2500	1000	200+	0.1	3.0	10.0	5.9	1.0
112.5	2	8.4	7.9	24	0.6	1.2	4.7	13.0	120	6.0	0.1	1.0	180	2400	1000	200+	0.1	3.3	10.0	5.4	1.0
114.5	2	8.3	7.8	25	0.6	1.1	4.8	14.0	120	6.0	0.1	1.0	180	2300	960	200+	0.1	4.6	11.0	6.1	1.0
116.5	2	8.1	7.6	25	0.6	1.1	4.8	16.0	120	6.0	0.1	1.0	180	2300	960	200+	0.1	5.4	11.0	7.2	1.0
118.5	2	7.8	7.4	26	0.5	0.9	4.8	18.0	120	6.0	0.1	1.0	180	2300	950	200+	0.1	6.8	13.0	6.8	1.4
120.5	Coal																				
122.5	Coal																				
124.5	2	7.9	7.4	30	0.7	0.8	4.6	16.0	120	5.0	0.1	1.0	170	2300	910	200+	0.1	7.1	16.0	11.0	1.6
126.5	2	8.1	7.6	32	1.0	0.9	4.1	18.0	120	5.0	0.1	1.0	170	2300	910	200+	0.1	6.3	14.0	11.0	1.5
128.5	2	8.2	7.7	34	0.8	0.9	4.2	26.0	120	6.0	0.1	1.0	180	2300	910	200+	0.1	6.1	14.0	10.0	1.6
130.5	Coal																				
132.5	Coal																				

*Composite

(Analyses by Agricultural Consultants Laboratories. Coal not analyzed. 2 in Texture column indicates highly compacted silt and clay that would have to be pulverized for plant propagation.

Table 3

Lithologic Description of Core From Drill Hole 3C-15
At the Proposed Jacobs Ranch Mine,
Campbell, County, Wyoming

Depth of Interval (feet)	Description
0. - 42.5	Sand, buff to gray-brown, fine to coarse-grained, subangular to rounded, quartz and black chert. Upper portion is clean sand. Sand becomes more clayey with depth.
42.5 - 64.5	Carbonaceous claystone, dark gray to gray-brown with occasional iron oxide lenses, very slightly sandy, medium sand grains, occasional gypsum crystals (?), slightly to very calcareous below 52.0 feet. Claystone becomes slightly silty below 57.0 feet.
64.5 - 73.0	Shale, dark to blackish-gray, occasional iron oxide stain, slightly silty and slightly sandy; upper and lower contacts are gradational and interfingering.
73.0 - 89.5	Interlayered sandstone, sandy shale, and sandy claystone, light gray to gray, sandstone is very fine to fine-grained, very clayey, and slightly calcareous. upper and lower contact is gradational and interfingering.
89.5 - 111.5	Claystone, light gray, clean, grades into carbonaceous claystone at 107.5 feet, slightly fissile, contains 1/4 to 1-foot thick stringers of black carbonaceous shale.
111.5 - 119.0	Carbonaceous shale and carbonaceous claystone dark brown to blackish-gray, interlayered, occasional woody impressions are present.
119.0 -	Coal.

Strata in the lease area dip to the west-southwest at 1 to 2 degrees following the regional trend. An interruption to this trend occurs in sections 3 and 7 where a slight warping produced an east-west trending syncline of very small magniture.

Coal

In the southwest part of the proposed Jacobs Ranch mine (sec. 15), the Wyodak coal is a single bed 60 to 64 feet thick (Figures 5 and 6). Northward and northeastward from sec. 15 the coal splits into three beds (Figure 5; Section B-B'). The company calls the uppermost bed the Upper Wyodak coalbed; the middle is called the Lower Wyodak 1 coalbed and the lowermost is the Lower Wyodak 2 coalbed (Figure 5). The minable part of the Upper Wyodak ranges from 5 to 12.5 feet thick and averages 8.1 feet thick. It is thickest in the northwest part of the lease area and thins to the south and east (Figure 6). This minable thickness of the Upper Wyodak bed is overlain by as much as eight feet of interbedded shale and coal that is not considered to be minable. Shale and/or sandstone ranging from 0 to 45 feet in thickness separates the Upper Wyodak and the Lower Wyodak 1 coalbeds. The area of thickest separating strata trends in a southeast direction through sections 3, 10, 11, 12 (Figure 7). The Lower Wyodak 1 coalbed, which averages 43 feet thick, ranges from 30 feet in thickness in the northeast part of the lease to 60 feet thick in sec. 15 in the southwest part of the lease as shown on the isopach map (Figure 6). Shale separates the Lower Wyodak 1 and Lower Wyodak 2 coalbeds. The shale thickens northeastward from 0 feet in sec. 15 to as much as 73 feet in sec. 1 (Figure 5). The Lower Wyodak 2 coalbed has a maximum thickness of only 8.5 feet and an average thickness of 5.9 feet in the lease area and will be mined only where its thickness ratio to the shale between it and the Wyodak 1 bed is 1:1 (Figure 8).

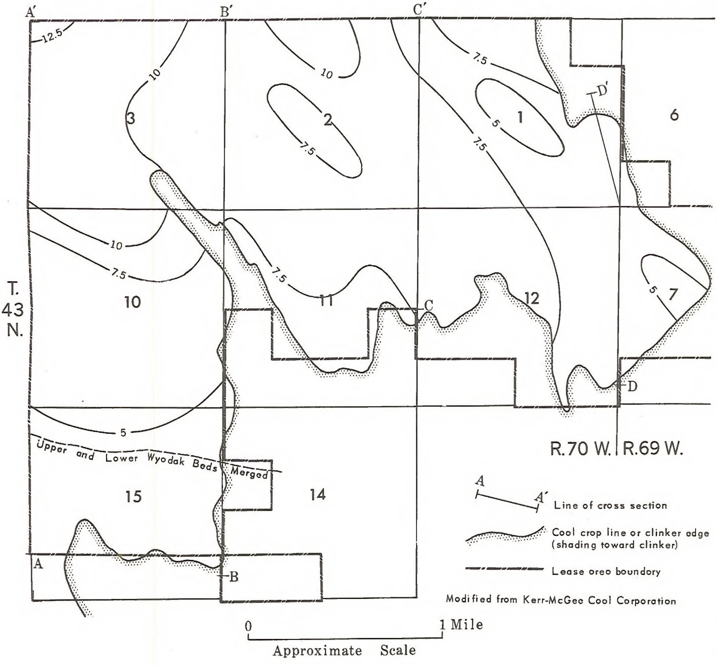


Figure 5

Thickness, in Feet, of the Upper Wyodak Coalbed at the Proposed Jacobs Ranch Mine, Campbell County, Wyoming

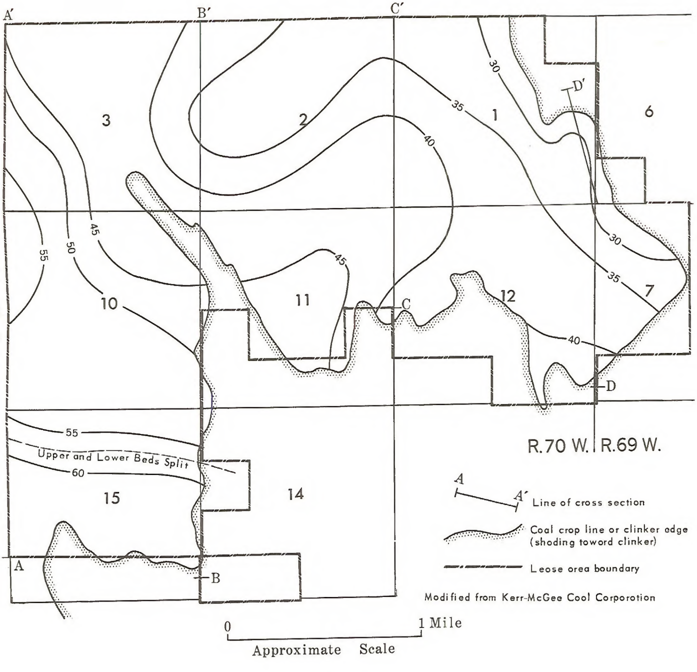


Figure 6

Thickness, in Feet, of the Lower Wyocak 1 Coalbed at the Proposed Jacobs Ranch Mine, Campbell County, Wyoming

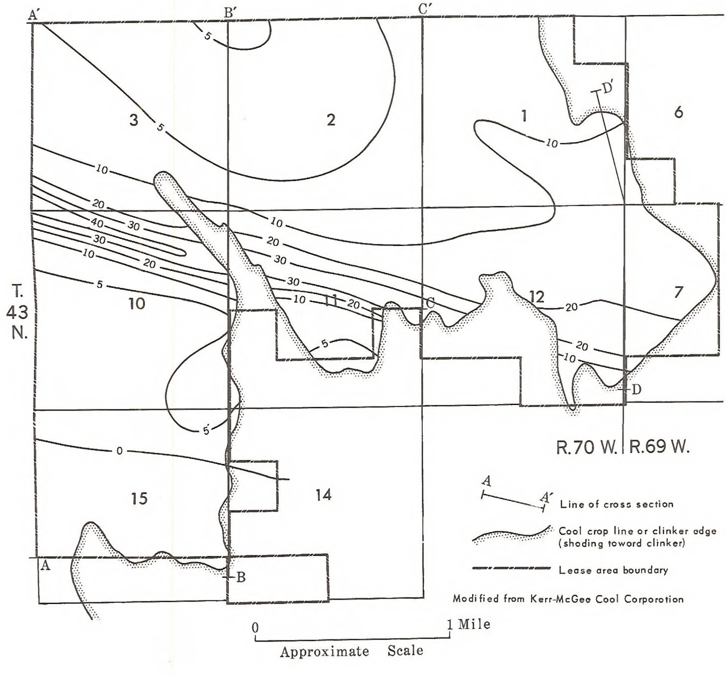


Figure 7

Thickness, in Feet, of Shale Separating the Upper Wyocak and Lower Wyodak 1 Coalbeds at the Proposed Jacobs Ranch Mine, Campbell County, Wyoming

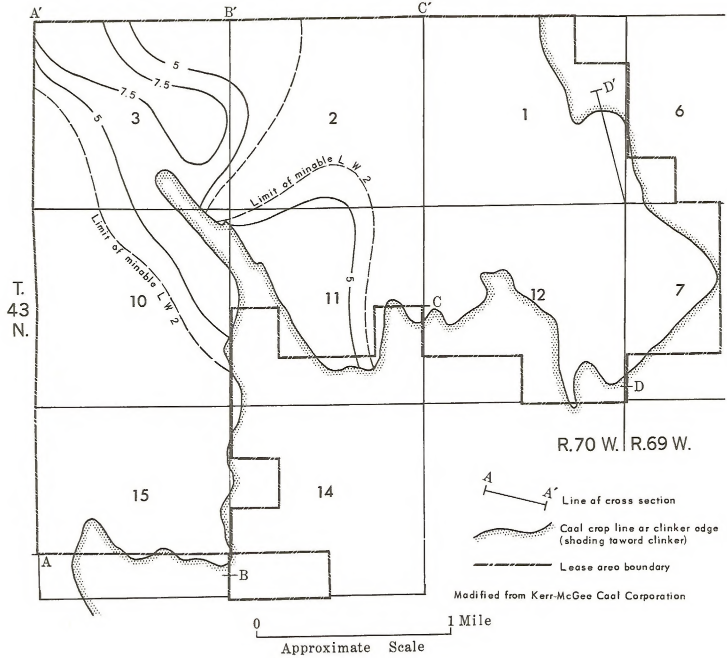


Figure 8

Thickness, in Feet, of the Lower Wyodak 2 Coalbed at the Proposed Jacobs Ranch Mine, Campbell County, Wyoming

Quality of the coal

Based on analyses supplied by Kerr-McGee Coal Corporation, the coalbeds to be mined at the Jacobs Ranch mine are subbituminous C in rank. Weighted averages of proximate and ultimate analyses of the three coalbeds as supplied by Kerr-McGee Coal Corporation are listed in Table 4 and the analyses for composite coal samples of each bed are shown in Table 5. The Upper Wyodak coalbed has an average sulfur content nearly three times as much as the Lower Wyodak 1 bed and almost four times as much as the Lower Wyodak 2 coalbed. Organic sulfur contributes 80 to 90 percent of the total sulfur, pyrite 4 to 8 percent, and sulfate 1 to 3 percent. The ash fusion temperature and the oxide content of the ash of coal samples of each bed are shown in Table 6. The range in values of the various analyses of all beds at the proposed mine are listed in Table 7. Sulfur contents and Btu values of the coalbeds are shown diagramatically in Figures 9 through 12. A composite sample of each bed was analyzed for trace elements in raw coal and in ash; results are tabulated in Table 8. Data were obtained through emission spectographic analysis by Core Laboratories, Inc., Casper, Wyoming. The analyses show no anomalous amounts of trace elements.

Quantity of the coal

Estimates of coal in the proposed Jacobs Ranch mine are given in Table 9. Also shown in the table are the quantity of overburden to be stripped in each section and the ratio of overburden to recoverable coal. Calculations by U.S. Geological Survey personnel agree within 1 to 1.5 percent of these company calculations. All the coal is under less than 150 feet of overburden except for about 5 million tons in the Upper Wyodak coalbed and 23 million tons in the Lower Wyodak 1 coalbed in the northern half of section 3.

Table 4

Weighted Average of Proximate, Ultimate, Btu, and Sulfur Analyses of Coal, as Received Basis, from Beds at the Proposed Jacobs Ranch Mine. (All Analyses Except Btu are in Precent.)

	Upper Wyodak Bed	Lower Wyodak 1 Bed	Lower Wyodak 2 Bed	Average
Moisture	28.30	28.99	29.17	28.96
Volatile Matter	32.85	31.08	29.75	31.26
Fixed Carbon	32.08	34.32	34.15	34.02
Ash	6.77	5.57	6.83	5.76
Hydrogen	3.68	3.44	3.23	3.46
Carbon	48.45	48.76	48.31	48.70
Nitrogen	0.71	0.71	0.70	0.71
Oxygen	11.94	12.10	11.49	12.06
Chlorine	0.01	0.01	0.01	0.01
Sulfur	1.06	0.39	0.27	0.47
Btu	8677	8518	8312	8527
Forms of sulfur				
Sulfate	0.013	0.013	0.008	0.013
Pyritic	0.088	0.059	0.064	0.063
Organic	0.962	0.317	0.198	0.397
Number of samples	24	28	8	--
Average thickness (feet)	8.1	43.0	5.9	--

Source: Kerr-McGee Coal Corporation 1973.

Table 5

Proximate, Ultimate, Btu, and Sulfur Analyses for Composite Samples of Each Coalbed at Proposed Jacobs Ranch Mine, T43N, R69, and 70W, Campbell County, Wyoming

(All analyses except Btu are in percent.)

	Upper Wyodak Bed		Lower Wyodak 1 Bed		Lower Wyodak 2 Bed	
	As received	Moisture free	As received	Moisture free	As received	Moisture free
Moisture	27.20	---	28.48	---	27.98	---
Volatile matter	32.43	44.55	30.41	44.55	29.91	41.53
Fixed carbon	33.36	45.82	35.84	45.82	35.47	49.25
Ash	7.01	9.63	5.27	9.63	6.64	9.22
Hydrogen	3.77	5.18	3.54	4.95	3.57	4.95
Carbon	49.18	67.56	49.05	68.59	49.12	68.21
Nitrogen	.72	.99	.78	1.09	.78	1.08
Oxygen	11.06	15.18	12.54	17.53	11.62	16.13
Chlorine	.01	.01	.01	.01	.01	.01
Sulfur	1.06	1.46	.34	.47	.29	.41
Ash	7.01	9.63	5.27	7.37	6.64	9.22
Btu	8,669	11,909	8,519	11,912	8,310	11,616

Source: Kerr-McGee Coal Corporation.

Table 6

Characteristics of the Ash from Coal in Samples of Beds at the Jacobs Ranch mine (Analyses provided by the Kerr-McGee Coal Corporation)

Weighted average, percent, of oxides in ash

Oxide	Upper Wyodak	Lower Wyodak 1	Lower Wyodak 2	Average
P_2O_5	0.55	0.47	0.82	0.51
SO_2	27.07	29.11	27.68	28.72
Fe_2O_3	9.73	6.72	10.30	7.44
Al_2O_3	15.26	16.36	14.73	16.07
TiO_2	1.24	1.58	1.39	1.52
CaO	22.08	24.67	22.59	24.15
MgO	4.27	4.53	4.53	4.50
K_2O	0.40	0.36	0.43	0.37
Na_2O	1.61	1.50	2.38	1.60
SO_3	15.89	12.78	10.22	12.93
Ash Content (Percent)	6.77	5.57	6.83	5.76
Ash Fusion Temperature - degrees Fahrenheit				
Initial	2132	2172	2168	2166
Softening	2174	2213	2203	2207
Hemis-pherical	2224	2268	2253	2261
Fluid	2297	2332	2328	2327

Source: Kerr-McGee Coal Corporation.

Table 7

Range in Values of Analyses of Coal from Beds at the Proposed Jacobs Ranch Mine.

(All analyses except Btu, Ash Fusion, and Grindability are in percent.)

PROXIMATE ANALYSES

As Received

Element or Compound	Range
Moisture	27.39 - 30.80
Ash	4.77 - 7.73
Volatile Matter	28.42 - 33.36
Fixed Carbon	31.82 - 37.04
Sulfur	0.34 - 0.79
Btu	8308 - 8829

Moisture Free

Element or Compound	Range
Ash	6.73 - 10.82
Volatile Matter	40.27 - 49.07
Fixed Carbon	44.73 - 52.49
Sulfur	0.48 - 1.11
Btu	11448 - 12261

ULTIMATE ANALYSES

As Received

Element or Compound	Range
Moisture	27.39 - 30.80
Ash	4.77 - 7.73
Sulfur	0.34 - 0.79
Nitrogen	0.67 - 0.78
Carbon	45.05 - 50.98
Hydrogen	3.10 - 3.81
Oxygen	10.40 - 14.02
Chlorine	0.01 - 0.01

Moisture Free

Element or Compound	Range
Ash	6.73 - 10.82
Sulfur	0.48 - 1.11
Nitrogen	0.95 - 1.11
Carbon	65.10 - 70.98
Hydrogen	4.48 - 5.40
Oxygen	14.90 - 20.26
Chlorine	0.01 - 0.01

Source: Kerr-McGee Coal Corporation.

Table 7 (Cont'd)

Range in Values of Analyses of Coal From Beds at the Proposed Jacobs Ranch Mine

(Analyses provided by Kerr-McGee Corporation, December 1973. All analyses except BTU, ash fusion and grindability are in percent.)

	RANGE
WATER SOLUBLE ALKALIES	
Na_2O	0.0190 - 0.0557
K_2O	.0025 - .0085
EQUILIBRIUM MOISTURE	21.92 - 24.62
ASH FUSION TEMPERATURES	
Initial	2,054 - 2,282°F.
Softening	2,090 - 2,326°F.
Hemispherical	2,153 - 2,371°F.
Fluid	2,234 - 2,452°F.
GRINDABILITY INDEX	46.7 - 60.3
SULFUR FORMS	
Pyrite	0.009 - 0.140
Sulfate	.006 - .037
Organic	.280 - .712
Total average	.340 - .790
MINERAL ANALYSIS OF ASH	
P_2O_5	0.10 - 0.92
SiO_2	22.38 - 34.93
Fe_2O_3	.60 - 12.18
Al_2O_3	11.94 - 20.68
TiO_2	1.02 - 4.05
CaO	16.98 - 34.28
MgO	3.10 - 5.81
K_2O	.16 - .92
Na_2O	.38 - 3.70
SO_3	9.73 - 18.96
Undetermined	.09 - 7.77

Table 8

Emission Spectrographic Analyses in Percent of Elements and Oxides in Coal and Ash from Composite Samples of Coalbeds at the Proposed Jacobs Ranch Mine, Campbell County, Wyoming

	Upper Wyodak Bed		Lower Wyodak 1 Bed		Lower Wyodak 2 Bed	
Element	Coal (as received)	Ash	Coal (as received)	Ash	Coal (as received)	Ash
Aluminum (Al_2O_3)	0.3	High	0.3	High	0.5	High
Antimony	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Barium	0.02	0.2	0.02	0.2	0.02	0.2
Beryllium (BeO)	< 0.0005	0.0001	< 0.0005	0.0001	< 0.0005	0.0001
Bismuth	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001
Boron	0.001	0.05	0.001	0.05	0.001	0.05
Calcium (CaO)	0.5 - 1	High	0.5 - 1	High	3.0	High
Cadmium	< 0.001	< 0.005	< 0.001	< 0.005	< 0.001	< 0.005
Cerium (CeO_2)	ND	ND	ND	ND	ND	ND
Chromium	ND	0.01	ND	0.01	ND	0.005
Cobalt	ND	0.005	ND	0.005	ND	0.005
Columbium (Niobium) (Nb_2O_5)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Copper	0.002	0.01	0.001	0.02	0.002	0.01
Gallium	< 0.001	< 0.001	< 0.001	0.001	< 0.001	0.001
Germanium	< 0.002	ND	< 0.005	ND	< 0.005	ND
Iron	0.5	3.0	0.1	3.0	0.2	3.0
Lanthanum (La_2O_3)	ND	ND	ND	ND	ND	ND
Lead	< 0.001	0.05	< 0.001	0.05	< 0.001	0.05
Lithium (LiO_2)	< 0.01	ND	< 0.01	ND	< 0.01	ND
Manganese (MgO)	0.001	0.02	ND	0.02	0.001	0.03
Magnesium	Low	Medium	Low	Medium	Low	Medium
Molybdenum	< 0.002	< 0.001	< 0.002	< 0.001	< 0.002	< 0.001
Neodymium (Nd_2O_3)	ND	ND	ND	ND	ND	ND
Nickel	< 0.005	0.005	< 0.005	0.002	< 0.005	0.002
Phosphorus	ND	Low	ND	Low	ND	Low
Silver	< 0.001	0.001	< 0.001	0.001	< 0.001	0.001
Silicon (SiO_2)	Medium	High	Medium	High	Medium	High
Sodium (Na_2O)	0.005	0.5	0.005	0.3	0.005	0.3
Strontium	ND	0.1	ND	0.1	ND	0.1
Tantalum (Ta_2O_5)	ND	ND	ND	ND	ND	ND
Thorium (ThO_2)	ND	ND	ND	ND	ND	ND
Tin	< 0.001	0.001	< 0.001	0.001	< 0.001	0.001
Titanium	0.02	0.2	0.02	0.3	0.02	0.1
Tungsten	ND	ND	ND	ND	ND	ND
Uranium (U_3O_8)	ND	ND	ND	ND	ND	ND
Vanadium	< 0.01	0.02	< 0.01	0.02	< 0.01	0.02
Yttrium (Y_2O_3)	ND	0.005	ND	0.001	ND	0.001
Zinc	< 0.001	0.1	< 0.001	0.05	< 0.001	0.05
Zirconium (ZrO_2)	ND	0.01	ND	0.01	ND	0.005
Cesium	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Gold	X	X	X	X	X	X
Hafnium	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Indium	ND	ND	ND	ND	ND	ND
Palladium	X	X	X	X	X	X
Platinum	X	X	X	X	X	X
Rhenium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Rubidium	0.01	0.01	0.01	0.01	0.01	0.01
Tellurium	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Thallium	ND	ND	ND	ND	ND	ND
Potassium	0.2	0.5	0.2	0.5	0.3	0.7

High > 10%
Medium ± 1% - ± 10%
Low < 1%
X Not Analyzed For
ND Not Detected

Source: Kerr-McGee Corporation

Table 9

Available coal and quantity of overburden at proposed Jacobs Ranch Mine, T43N, R69 and 70W, Campbell County, Wyoming

Location	Upper Wyodak Coalbed	Lower Wyodak * Coalbed	Lower Wyodak ** Coalbed*	Total Coal in Place	Recov-erable Coal **	Overburden (includes rocks between coalbeds)	Ratio Overburden to Recoverable Coal
T43N, R69W Sections 6 and 7	1,334	7,864	0	9,198	8,278	18,502	2.23
T43N, R70W Section 1	6,305	28,068	0	34,373	30,936	67,481	2.18
Section 2	9,895	41,557	2,090	53,542	48,188	121,633	2.52
Section 3	10,505	48,004	4,869	63,378	57,040	142,718	2.50
Section 10	6,580	53,955	1,430	61,965	55,768	112,289	2.01
Section 11	4,234	27,077	2,399	33,710	30,339	47,951	1.58
Section 12	4,328	24,145	0	28,473	25,626	47,954	1.87
Section 15	1,296	45,161	0	46,457	41,811	60,172	1.43
Total	44,477	275,831	10,788	331,096	297,986	618,700	2.07

* Resources calculated only in areas where Lower Wyodak 2 coalbed will be mined.
** Assuming 90 percent recovery of coal in place.
Coal in thousands of short tons; overburden in thousands of cubic yards.

Source: Kerr-McGee Coal Corporation 1973.

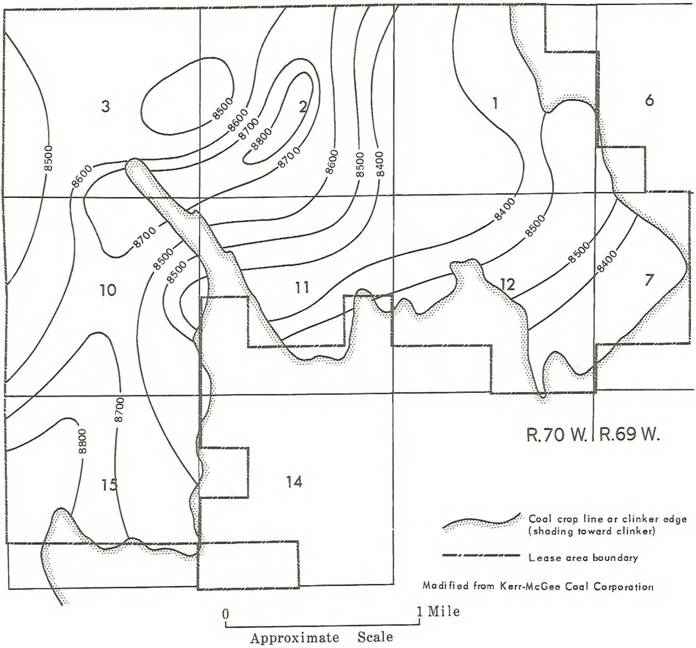


Figure 9

Average Weighted Btu Values of Combined Coalbeds at the Proposed Jacobs Ranch Mine, Campbell County, Wyoming

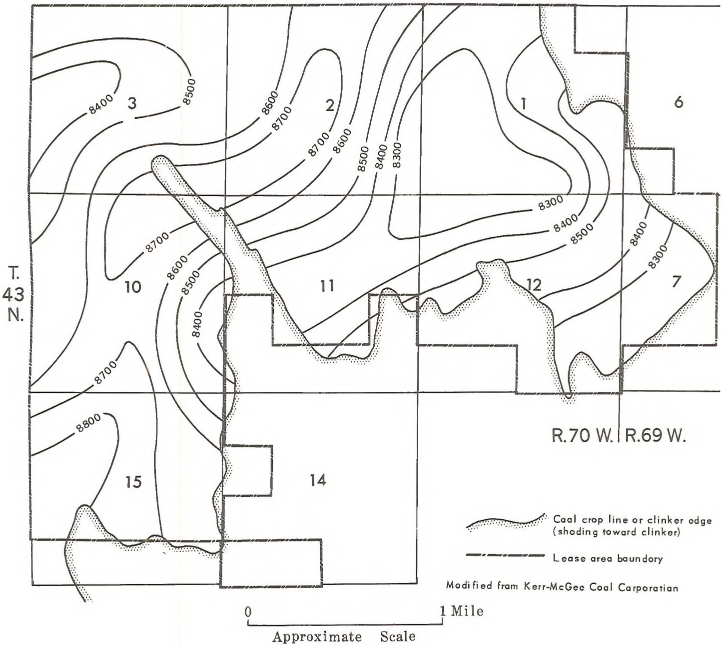


Figure 10

Average Btu Values of the Lower Wyocak 1 Coalbed at the Proposed Jacobs Ranch Mine, Campbell County, Wyoming

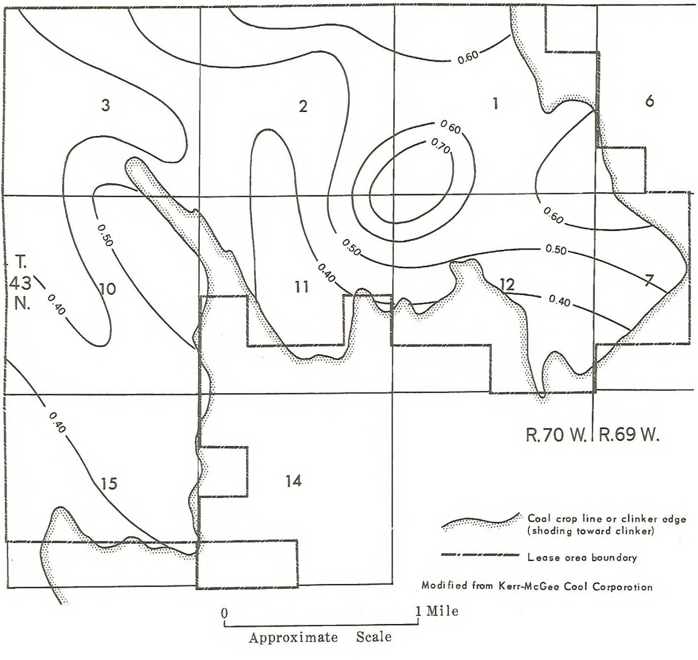


Figure 11

Average Weighted Sulfur Values of Combined Coalbeds at the Proposed Jacobs Ranch Mine, Campbell County, Wyoming

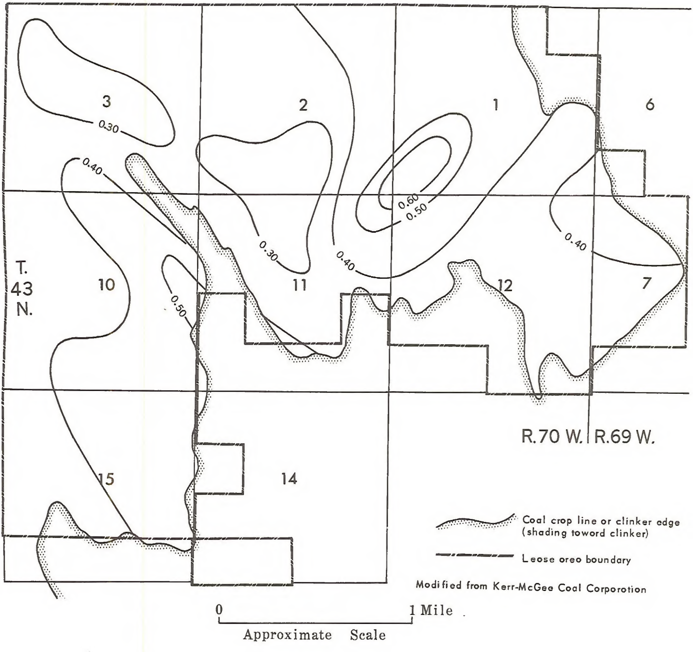


Figure 12

Average Sulfur Values of the Lower Wyodak 1 Coalbed at the Proposed Jacobs Ranch Mine, Campbell County, Wyoming

Other minerals

Deposits of uranium or minerals other than coal are not known to occur within the lease.

Areas of clinker on the lease are sufficiently thick and widespread to provide road material and ballast. Small amounts of sand and gravel may be obtained locally from terraces and floodplains along intermittent streams.

Oil and gas

The Kerr-McGee Coal Corporation's federal coal lease in T43N, R69 and 70W presently contains one producing oil well and two plugged and abandoned oil and gas test holes. No other wells are known within the lease area; other oil and gas tests to any formation within the area could be applied for at any time. Data on the existing wells in the Kerr-McGee lease area follow:

During May and June 1969, a well was drilled and abandoned 660 feet from north line and 660 feet from west line (on Lot 1 or NW°NW°) sec. 7, T43N, R69W, on public oil and gas lease Wyoming-6484; ground elevation is 4,893 feet; 8 5/8-inch surface casing was set at 423 feet; total depth is 9,864 feet in Morrison Formation.

During March through May 1970, a producing well was drilled 660 feet from north line and 660 feet from west line (C Lot 4 or NW°NW°) sec. 2, T43N, R70W, on a private oil and gas lease in the Hilight field extension area; ground elevation is 4,861 feet; 9 5/8-inch surface casing set at 1,084 feet; 5 1/2-inch production casing cemented at 9,585 feet; total depth is 9,585 feet; the Lower Cretaceous Muddy Sandstone from 9,474 to 9,484 feet is the producing zone at an initial potential of 60 barrels of oil per day. Present rate of production averages seven barrels of oil per day.

During March and April 1970, a well was drilled and abandoned 1,980 feet from south line and 660 feet from west line (C NW¼SW¼) sec. 2, T43N, R70W, on a private oil and gas lease; ground elevation is 4,850 feet; 9 5/8-inch surface casing was set at 1,004 feet; total depth is 9,585 feet in the Lower Cretaceous Skull Creek Shale.

Water Resources

Ground water

Aquifers

Formations within about 3,000 feet of the land surface in the vicinity of the Kerr-McGee coal lease that contain aquifers are, in order of increasing depth below land surface, the Wasatch, Fort Union, Lance, and Fox Hills. The only aquifers that are expected to be affected by mining operations are the coalbeds and the overlying aquifers in the overburden (Wasatch) to be removed during mining operations.

In the southern half of Campbell County, the land surface slopes eastward. The beds within these formations, however, dip very gently westward toward the axis of the Powder River Structural Basin. Many separate water levels are present in the thick sequence of Tertiary and Upper Cretaceous rocks that underlie the land surface. The water levels in these rocks are at higher altitudes than are the rock outcrops farther to the east.

Water movement

The higher water levels in the center of the basin preclude water movement basinward from the outcrop areas. Recharge in southern Campbell County occurs from infiltration of local precipitation on the topographic higher areas in the central and southern parts of Campbell County.

Surface water

Drainage and streamflow

The surface of the leased area is drained by tributaries of Little Thunder and Black Thunder Creeks. All tributaries originate within the area. Burning Coal Draw, a tributary of North Prong Little Thunder Creek, drains 54

percent of the leased area. Several small areas in sections 3 and 10 are shallow closed basins with no apparent outflow. The formation of these depressions may have been caused by the burning of underlying coalbeds.

The drainage pattern of the area is dendritic. The minor tributaries are ephermal streams with natural runoff occuring from snowmelt and rainfall. Several small seeps are located along sandstone outcroppings; however, flows from these seeps are not sufficient to cause perennial flow in tributary channels.

The major part (75 percent) of annual runoff occurs during the spring and summer months, generally as a result of convective storms. Culler (U.S. Geological Survey 1961) determined average summer runoff during 1951-54 to a stockpond located in the NE¼NE¼ section 10, T42N, R70W, to be 5.2 acre-feet per year. Drainage area to the stockpond is 0.66 square miles. Minor tributaries of the area commonly have periods of several years with no flow.

Surface water uses

The major use of surface water is for consumption by domestic and wild animals. Numerous stockponds are constructed on minor tributaries, and detention and retention of flows is afforded by these man-made structures. Several water wells provide water that is stored in small reservoirs for use by livestock. Spreader systems are used for irrigation of hay meadows and pastures along the downstream reaches of Little Thunder and Black Thunder Creeks, but due to the large variation in annual runoff, water supplies are not dependable for irrigation.

Erosion and sedimentation

Several bare areas show evidence of sheet and rill erosion, and gullies have formed in sections 11, 12, and 15.

Water quality

Water originating and flowing through the lease area contributes to flow in the Cheyenne River. Since a major portion of the drainage area upstream from the water quality sampling site near Spencer on the Cheyenne River is similar to the lease area, water quality sampled near Spencer should generally represent surface water quality in the lease area.

Dissolved solids concentration in the Cheyenne River near Spencer ranges from 1,000 mg/1 to 4,000 mg/1, but concentration outside this range may occur in the lease area. The increase in sodium and sulfate concentrations at low flows observed near Spencer should also occur in the lease area.

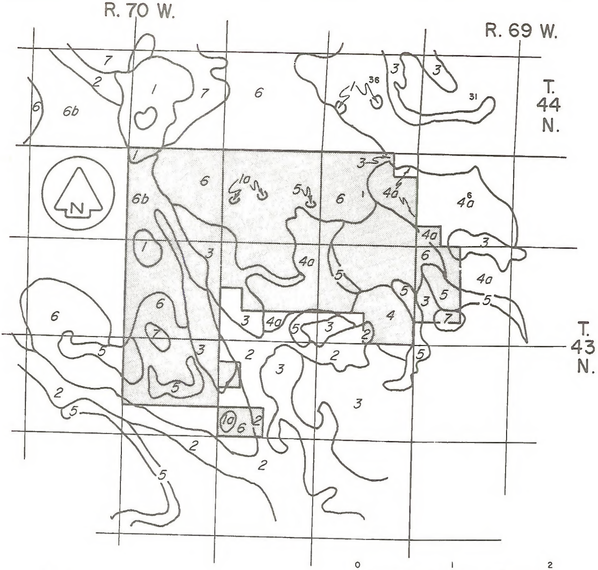
Vegetation

On better drained upland sites, vegetation of the Kerr-McGee lease is characterized by shrub steppe plant communities dominated by big sagebrush (*Artemisia tridentata*) (Figure 13). Domestic livestock have grazed these communities since the middle 1880's, so all are in an intermediate stage of plant succession. If overly heavy, grazing is thought to increase the density of big sagebrush or allow it to invade into grasslands. However, site conditions and degree of grazing intensity where this takes place have not been defined for northeastern Wyoming, nor is a historical record available for the lease area to indicate if big sagebrush should be considered an endemic part of the natural plant communities of this area.

The shrub overstory of these plant communities is composed almost entirely of big sagebrush. The height of this layer generally does not exceed 18 to 24 inches. Density (plants per unit area) will range from scattered to moderately closely spaced, but the crowns of individual plants rarely touch. Canopy coverage is in the 20 to 40 percent range.

Beneath the sagebrush overstory and mixed with it are species common to the Northern Great Plains to the east. Grasses and sedges predominate, but forbs are evident in the early part of the growing season (April-May).

The greater amount of Great Plains species in the plant mixture is the most likely reason for the theory that big sagebrush is an invader into what should be grasslands similar to those of the Northern Great Plains. Areas of low sagebrush density certainly have the appearance similar to these grasslands. However, it is also possible that the communities dominated by big sagebrush represent the vegetational transition (ecotone) between the Northern Great Plains grasslands to the east and the sagebrush shrubland more common to the west. Descriptions of the several plant communities follow and are summarized in Table 10.



LEGEND

1	Western Wheatgrass-Foxtail Barley
1a	Western Wheatgrass-Slender Spikerush
2	Inland Saltgrass-Western Wheatgrass
3	Bluebunch Wheatgrass-Blue Grama
4	Big Sagebrush/Western Wheatgrass-Blue Grama*
4a	Big Sagebrush/Western Wheatgrass-Blue Grama*
5	Big Sagebrush/Western Wheatgrass-Blue Grama*
6	Big Sagebrush/Needle and Thread-Blue Grama*
6b	Big Sagebrush/Needle and Thread-Blue Grama*
7	Big Sagebrush/Blue Grama
	Boundary of Kerr-McGee Coal Property

*Difference in Soils

Figure: 13 Vegetation community boundaries (Kerr-McGee Coal Property)

No.	Acres	Vegetation (Community-Type)	Soil Series	Landform
1	110	Western Wheatgrass-Foxtail barley	McKenzie clay	Playa (dry)
1a	30	Western Wheatgrass-Slender spkerush	McKenzie clay	Playa (wet)
2	50	Inland saltgrass-Western wheatgrass-Blue grama	Arvada clay loam loam	Alluvial lowland (saline-alkali)
3	490	Bluebunch wheatgrass-Blue grama	Wibaux searing complex Rough broken-searing	Scoria land
4	150	Big sagebrush/Western wheatgrass-Blue grama	Renohill clay loam	Sideslope (rolling)
4a	520	Big sagebrush/Western wheatgrass-Blue grama	Renohill loam	Sideslope (rolling)
5	280	Big sagebrush-Western wheatgrass-Blue grama	Rough broken land	Rough Broken land
6	2132	Big sagebrush/Needle-and-thread-Blue grama	Ulm loam (reddish sub-soil)	Upland (Undulating)
6b	540	Big sagebrush/Needle-and-thread-Blue grama	Ulm clay loam (shallow)	Upland
7	50	Big sagebrush/Blue grama	Renohill clay loam	Upland (undulating)
Total	4352			

* For detail description of the ecosystems see description in appendix for this lease

Table 10

Ecological Relationships of the Kerr-McGee Lease

Ecosystem No. 1: Western wheatgrass-foxtail barley grassland on playas with deep clayey soils.

This ecosystem is found on the playas which are present on nearly level uplands. Soils are deep, clayey, and subject to periodic inundation from runoff but water does not remain above the surface for long periods. The general appearance of the vegetation is a sparsely vegetated grassland dominated by western wheatgrass. Shrubs or trees do not occur. When not inundated or muddy, this ecosystem can provide grazing for both domestic livestock and wildlife. It can provide water for animals when inundated and may be habitat for amphibians and aquatic birds.

Ecosystem No. 1a: Western wheatgrass-slender spikerush grassland on plains with deep clayey soils.

This grassland ecosystem is found on small playas which are present on nearly level uplands. Soils are deep, clayey, and subject to periodic inundation from runoff. The period of high water appears to be longer than in the western wheatgrass-foxtail barley ecosystem (No. 1) and the vegetative cover is greater, but the general appearance is still a grassland devoid of woody vegetation. When dry, this ecosystem can be grazed by livestock and wildlife; when set, it can provide water for animals and may be habitat for amphibians and other aquatic wildlife.

Ecosystem No. 2: Inland saltgrass-western wheatgrass, blue grama, riparian grassland on alluvial lowlands with deep saline-alkaline soils.

This ecosystem is confined to clayey alluvial soils in flat, narrow, valleys of stream courses where saline salts accumulate. These valleys may be periodically flooded by runoff water. The vegetation is a grassland community

type dominated by inland saltgrass. The ecosystem is grazed by both domestic livestock and wildlife.

Ecosystem No. 3: Bluebunch wheatgrass-blue grama grassland on clinker land with shallow gravelly soils.

This ecosystem occurs on ridges and hills derived from reddish colored clinker. Soils are shallow and gravelly and tend to be droughty. The general character is a somewhat sparsely vegetated grassland characterized by scattered tussocks of bluebunch wheatgrass. The ecosystem provides grazing for livestock and wildlife, and the steeper outcrops may provide nesting or perching sites for owls, hawks, and other cliff-dwelling birds.

Ecosystem No. 4: Big sagebrush-western wheatgrass-blue grama shrub steppe on dissected sideslopes with moderately deep soils.

This ecosystem occurs on sideslope terrain which is somewhat dissected. Soils are shallow to moderately deep and tend to be clay loam or clayey in texture. The vegetation is a shrub steppe with big sagebrush (_Artemisia tridentata_) the shrub layer dominant. The herbaceous layer is characterized by western wheatgrass (_Agropyron smithii_) and blue grama (_Bouteloua gracilis_). It provides grazing for livestock and wildlife.

Ecosystem No. 4a: Big sagebrush western wheatgrass-blue grama shrub steppe on dissected sideslopes with moderately deep soils with loamy surface.

This ecosystem occurs on sideslope terrain which is somewhat dissected. Soils are shallow to moderately deep and tend to be more loamy in texture than those in Ecosystem No. 4. The vegetation is a shrub steppe with big sagebrush (_Artemisia tridentata_) as the shrub layer dominant. The herbaceous layer is characterized by western wehatgrass (_Agropyron smithii_) and blue

grama (*Bouteloua gracilis*). This is also a major ecosystem on the lease area. It provides grazing for livestock and wildlife.

Ecosystem No. 5: Big sagebrush-western wheatgrass-blue grama shrub steppe on rough broken land sideslopes with shallow clayey soils.

This ecosystem is present on rough and broken topography. Soils are shallow, textures tend to be somewhat clayey, but drainage is not impeded. The vegetation is a very open shrub steppe of big sagebrush (*Artemisia tridentata*) with a sparse herbaceous understory of grasses. It is grazed by both livestock and wildlife but is low in herbage production.

Ecosystem No. 6: Big sagebrush-needleandthread-blue grama shrub steppe on nearly level to gently sloping uplands with moderately deep loamy soils.

This ecosystem is characterized by gently sloping to rolling uplands with moderately deep soil with texture loamy to sand. The vegetation is a shrub steppe community type with big sagebrush as the shrub layer. The understory is composed of grasses and forbs common to the Great Plains area. It is used by both livestock and wildlife for grazing and is moderately productive.

Ecosystem No. 6b: Big sagebrush-needleandthread-blue grama shrub steppe on gently sloping to rolling uplands with shallow loamy soils.

This ecosystem is characteristic of nearly level to gently sloping uplands with shallow loamy to sandy textured soils. The vegetation is a shrub steppe community type with big sagebrush as the shrub layer dominant. The understory is composed of grasses and forbs common to the Great Plains grassland. This is the most widely distributed ecosystem on the lease area. It is used by both livestock and wildlife for grazing and is moderately productive.

Ecosystem No. 7: Big sagebrush-blue grama shrub steppe on gently sloping uplands moderately deep clay loam soils.

This ecosystem is characteristic of nearly level to gently sloping uplands with clay loam textured soils. The vegetation is a shrub steppe community type with big sagebrush as the shrub layer dominant. The herbaceous layer has blue grama as the major grass. Western wheatgrass and needleandthread are rare. The ecosystem is used by both livestock and wildlife for grazing and is moderately productive.

Archeological and Paleontological Values

An archeological survey of the surface area of the Kerr-McGee coal mining lease has been conducted by Olof W. Doud for the Kerr-McGee Coal Corporation (Kerr-McGee Corporation 1973, Appendix B). This survey produced no evidence of any major archeological values on the lease area, and no prehistoric sites are known or recorded within the area. Two projectile points were found near the dry lake beds, but they were not associated with any sites.

Scattered flakes from early tool making were observed by Doud throughout the area. Flake concentrations were heaviest near the meadows along the southern boundary of Section 11. No indications of any campsites, rock shelters, petroglyphs/pictographs, or buffalo jumps were found. The presence of the scattered flakes in the area is typical of the region and little to no value is placed on the significance of these by Doud.

Various references as well as persons at the local and state level were consulted for significant information.

There has been no detailed study of the paleontology of the lease area. Therefore, little is known as to the possibility of paleontology material being found on the lease site. However, the Wasatch and the Ft. Union Formations that lie on the lease area are likely to yield certain vertebrate remains.

Historical Values

The National Register of Historic Places, the State Historian, and local references and people were consulted and no known significant sites, trails, or areas occur on this lease area. However, Indian tribes probably passed through and hunted buffalo and other game in the area. No campsite or other evidence of permanent habitation by these tribes are known on the lease.

During the survey conducted by Olaf W. Doud for the Kerr-McGee Coal Corporation, nine residential structures or sites were located on the lease area. All of these sites were abandoned some time ago, probably between 1930-1935. The names of the original tenants, approximate construction dates, and structure condition are listed in Appendix B of the Kerr-McGee Corporation "Mining and Reclamation Plan and Environmental Description".

No record is given as to the importance of any family or site as being significant for historical purposes. However, of interest is the fact that the cabin in section 15 belonged to a black family named Simpson who settled in 1919 or 1920. Also, a post office and country store were located in section 2 and owned by a Jacob Kohlrus family. The Simpson cabin is in reasonably good condition with the walls and roof still up, but part of the walls and roof have been removed on the Kohlrus family post office and country store.

There were two principal reasons for land being abandoned. Many potential farm families settled on tracts of 160 to 640 acres that were physically and economically unfitted for cultivation. Also, an even larger number of settlers either originally or subsequently attempted livestock production on units of one or two sections that proved to be inadequate for this type of operation.

Cultivated tracts were usually less than 160 acres in size. In some instances, the land was tilled only to comply with a provision of the Homestead Act. Homestead principles developed for a humid climate further east were misapplied to the semiarid plains. Operators remaining in the area encountered grave financial difficulties. Tax delinquency was a serious problem. County governments were hard pressed to maintain schools, roads, and other government activities.

Settlement, attempted cultivation, and abandonment of the land resulted in government action. Homesteading continued until 1934 when the public domain was closed to homestead entry. A considerable acreage of these old homestead lands were repurchased by the Federal Government in the 1930's.

The Thunder Basin National Grassland was initiated in 1934 as the Northeastern Wyoming Land Utilization Project under the Agricultural Adjustment Administration. The program since that time has been administered by the Resettlement and the Farm Security Administrations, the Bureau of Agriculture Economics, the Soil Conservation Service, and since 1954 the Forest Service.

The project was started late in 1934; purchasing of units was started in 1935; and the last of the purchases was made in the early 1940's. The original project included the area now in the Thunder Basin Grazing Association and the Spring Creek Association.

Aesthetics

The overall landform of the lease area is a result of sedimentary deposits from upper Cretaceous to recent geologic times and the natural weathering that has occurred since the deposition.

The gently rolling uplands comprise about 70 percent of the lease area. The landform gives a very weak landscape character, but stronger form is displayed by severely eroded areas along the eastern and southern sides of the lease area. This area is typical of the coal burnline that separates the uplands from the adjacent Rochelle Hills of the Fort Union Formation. These eroded areas display more angular forms than the smoothly curving forms of the rolling uplands.

Textures in the gently rolling uplands are smoother than those displayed in the eroded portions. The natural vegetation consisting of fairly evenly mixed sagebrush and native grasses gives a moderately roughened texture to the surface of the land. Textures in the severely eroded areas are generally rougher than the rolling uplands due to more scattered groupings of sagebrush and grass along with the rougher texture created by erosion. Various parts of the lease area have been cleared for cultivation at one time or another and have since revegetated with wild grasses and cactus. These areas have the smoothest textures displayed in the lease area due to the absence of the coarser sagebrush.

Line as a landscape element is very subtle or absent. With the weak form, no strong line contrast exists between forms present in the landscape.

Colors within the area are muted tones of grays, greens, reds, and browns. The brightest colors occur in spring and early summer when the sage and grass vegetation is its greenest and wildflowers are in bloom. The most color contract occurs in wintertime when the white snowdrifts contrast with the darker tones of soils and winter vegetation. The predominant color tones for most of

the year are light browns and light grays. These are displayed by the grass as the seasons progress from spring through winter. Grays and light browns are displayed when soil is exposed by erosion or other disturbance. Reddish tones appear in the clinker soil zones, mostly in the rougher eastern edge of the lease.

In the gently rolling upland terrain with only low vegetation, it is very difficult for the observer to define size or distance. In the more severely eroded areas, the frame of reference is closer to the observer and a feeling of enclosure enables him to relate to the scale much easier than when he is in the wide open areas.

At present, few intrusions have been introduced into the general landscape. Fences, roads, windmills, old cabins, storage tanks, and utility lines are the major intrusions found in the area. Fences, being normally three- or four-strand wire on wood and steel posts, are absorbed into the landscape beyond the foreground zone due to the vertical accent on an otherwise horizontal plane. Utility lines give the same relative effect on the landscape as fences. These intrustions are spaced at intervals that prevent them from being undesirable or discordant in the landscape. The old cabins lend some historical interest to the general scene although they are in various stages of decay.

The landscape quality of the lease area is considered to be relatively low when compared to areas of rugged, dissected, and colorful mountains with much variety in form, line, color, and texture. However, on the microscale one can find much variety in plants, insects, wildlife, and soils from one area of the lease to another.

Wildlife and Fish

The lease area is habitat for a wide variety of wildlife. A list of known animals is included as Tables 29 to 32, Appendix C.

Big game

Pronghorn antelope

About 35 antelope have been living on the lease area. Their numbers have been decreasing slightly due to human activity on the lease area. There is some use of forbs such as cushion erigonum and rockcress. The few crested wheat fields on the lease area are used in early spring. Antelope begin to eat Douglas rabbitbrush in late spring and early summer before going back to sagebrush which provides the bulk of their diet. Big sagebrush is a crucial species for them but may be less important in this area where snowfall is light and does not remain on the ground long.

Suitable habitat is generally available throughout the lease area. There is cover for young fawns and for adults during severe storms. Much of the sagebrush is short, so antelope must go elsewhere to eat when snow cover remains for more than a week. Lack of water in outlying areas causes some winter concentration of the animals along Little Thunder Creek.

Antelope have adapted to domestic grazing and fencing patterns. They share range with both cattle and sheep. The greatest competition for feed is in the spring when cattle, sheep, antelope, and other grazing animals eat bluegrasses. Sheep use sagebrush from late fall through the winter, so there is some conflict when they are with antelope on winter range.

The Kerr-McGee lease is in the south end of State Antelope Management Area 24 which covers the southeast corner of Campbell County, south of Gillette

(Highway 16) and east of Highway 59. In 1971 and 1972, 750 hunting permits were issued in Area 24 for 20 to 30 days of October. In 1973, the season was October 1 to 21, and the number of permits was increased to 900.

Mule deer

This is a fringe area for mule deer and not a critical habitat except for the few that have moved in from the main herd in the Rochelle Hills to the east. They stay close to cover and are usually found in brushy bottoms along streams and in nearby rough land. Most are in the southwest corner of the lease area and along the North Prong drainage. Deer tend to remain yearlong in the same area but move short distances when snow covers the food supply. Some move back into the ponderosa pine hills to the east for part of the winter.

Most of their water and forage requirements are met in the drainage bottoms. Grasses and forbs are available during the spring and summer and sagebrush is available in the drainage bottoms or on nearby uplands. A high percentage of the spring diet is made up of grasses, especially bluegrasses, sixweeks fescue, and cheatgrass, because they are the first plants to start growing. Grazing of forbs by deer reaches a peak in summer and decreases as the plants become unpalatable or unavailable. Then the deer begin to eat shrubs, mainly sagebrush.

Deer food habits conflict with livestock. Competition with livestock occurs in spring and summer when both types of animals graze succulent forage in the creek bottoms. Deer move from place to place to avoid livestock concentrations. Coyotes, bobcats, and eagles are predators on the deer.

The lease is in the Wyoming Game and Fish Department's Deer Management Area 21. For the last few years, the deer hunting has been for either sex. The 1973 hunting season was October 1 to 21. Most deer are taken as a sideline to antleope hunting.

Elk

Twelve elk were released in the hills east of this area in 1969. They spread out and have increased in number to about 45. These elk use the lease area sometimes but are not full-time residents on the lease.

Other Mammals

Predators and furbearers

The coyote is of economic significance as a predator and a furbearer. An estimate of the coyote population is not available, but the animals are considered to be increasing in numbers. There is a possibility that the increase is caused, in part, by an increase in rabbit populations. Control methods being practiced include trapping and shooting from the ground or from aircraft.

Coyotes are very adaptable and consume a wide variety of feeds including vegetation, small mammals, and occasional big game animals and livestock.

The red fox seems to be increasing. Its main food items are small mammals and birds. Foxes have not been controlled as predators. Recently fur prices have risen, causing an increase in trapping.

Bobcats are solitary animals and are normally less plentiful than foxes and coyotes. Bobcat numbers are increasing. Rough topography on the lease provides cover. Bobcats usually feed on small mammals or birds. As predators, bobcats usually do not receive quite as much attention as coyotes. They have been trapped recently for their fur.

Other furbearing predators on the lease include the long-tailed weasel, badger, skunk, and raccoon. Badgers feed on burrowing rodents and on many other small animals, including ground nesting birds and their eggs. Weasels eat many of the same animals.

Striped skunks feed on insects, fruits, mice and other small rodents, and also carrion if necessary. The spotted skunk eats insects, small rodents, lizards, salamanders, and snakes.

Raccoons are relatively few because of lack of suitable habitat. They usually prefer a moist habitat with trees. Their food includes crayfish, insects, grubs, roots, eggs, mice, fruit, and grain.

All of these small, furbearing predators are trapped on the lease for their fur, but most are taken while trapping for the more valuable furbearers.

Other small mammals

These are widely distributed over the area and are discussed in Part I. There is no information about these mammals specific to this lease. No prairie dog towns are on the lease area.

Upland game birds

The only upland game bird known to be on the lease is the sage grouse. There is no information from which to estimate numbers of sage grouse. Their summer range is spread over the lease; they probably winter south of the lease near the North Prong drainage. Strutting grounds on the lease area have not been identified and documented. Sage grouse management during the last few years has been directed toward opportunities for habitat improvement and a limited harvest. In 1973, the season was September 15 to 18.

Waterfowl and shore birds

Several species of waterfowl use the small reservoirs for resting during migration. They include mallards, pintails, gadwall, wigeons, teal, goldeneye, mergansers, and coots. Some mallards, gadwalls, and teal nest here also.

There are several shore birds associated with the small reservoirs, but little is known about them. The killdeer is common around the reservoirs, meadows, and along streams. Snipes, gulls, the American avocet, the Wilson's phalarope, and the longbilled curlew may be found around the water holes.

Other birds

Raptors found on the lease include the turkey vulture, marsh hawk, red-tailed hawk, Swainson's hawk, ferruginous rough-leg, golden eagle, bald eagle, and the American Kestrel. Their habits are discussed in Part I. Information about song birds and other birds discussed in Part 1 is applicable to the lease area.

Fish

There is no water suitable for fish on the Kerr-McGee lease area.

Reptiles and amphibians

The tiger salamander, boreal frog, and leopard frog frequent the playas, small reservoirs, and wet drainage bottoms. The great plains toad, lesser earless lizard, and eastern shorthorn lizard are present on the lease.

The prairie rattlesnake and western terrestrial garter snake are common.

Threatened Species

No threatened species have been reported as indigenous to the lease area.

Recreation

Recreation can best be described as people doing things for their physical or psychological well being. Few activities occur on this lease area that serve these needs.

Hunting antelope, deer, cottontail, jackrabbit, sage grouse, and waterfowl is the most participated-in activity with an estimated 75 visitor days use per year. Other activities such as sightseeing, artifact hunting, photography, and picnicking probably occur on the lease area in amounts of 1 to 20 visitor days per year.

Agriculture

Livestock grazing

Cattle ranching is the most important agricultural activity in this area. Dryland crop production is interspersed with grazing in the general area but not on the lease area. Some dryland farming was tried on the lease area but was unsuccessful and fields were abandoned in favor of native grass. Three ranch operations have interest in five pastures on the lease area.

Jacobs Land & Livestock, now a subsidiary of Kerr-McGee, has three pastures within the lease. Pasture #1 is approximately 400 acres, supporting 100 AUMs. Pasture #2 is approximately 960 acres, supporting 240 AUMs. Pasture #3 is a large pasture containing approximately 3,800 acres. The mined area will be at the north end of Pasture #3 where approximately 1,920 acres, supporting 480 AUMs, will be affected. There will be 820 AUMs affected by mining in this ranch unit. Franklin Realty has approximately 350 acres supporting 88 AUMs, and Reno Livestock has 80 acres and 20 AUMs within the lease area. ARCO and Kerr-McGee jointly control 760 acres supplying 190 AUMs that will be removed from grazing for base area and rail spurs. A total of 1,118 AUMs will be lost to mining.

Mining will also affect associated facilities such as fences, dams, and water wells. There are 6.25 miles of fence inside the lease area and an equal amount along the lease boundary. Five dams on the lease area accumulate water for livestock. One of these is on National Grassland in section 12 and holds 19.5 acre-feet of water. Other "spreader dams" exist for spreading irrigation water onto adjacent areas of both private and National Grassland. The lease also contains two water wells on private land.

Farming

Portions of the lease area were unsuccessfully farmed in the 1930's, and the land was returned to native range. The total area farmed is not known, but it was a very small part of the lease area. The only reliable method of obtaining a crop is with irrigation.

Ownership

This lease covers 4,351 acres of National Grassland and private land as follows:

National Grassland	640 acres
Franklin Realty	353 acres
Jacobs Land & Livestock	1,878 acres
Ruth Ann McKinzie	640 acres
Reno Livestock Corp.	80 acres
Atlantic Richfield	440 acres
Kerr-McGee	320 acres

Transportation Networks

Primary access roads

State Highway 59 which connects Douglas and Gillette provides general access to the mining area. It is a narrow, two lane, blacktop road. A 15-mile segment of the road from Gillette south was improved in 1972. In 1973, approximately eight miles of road was improved from Douglas north. Improvement consisted of widening the travel lanes and road shoulders and repaving.

Secondary access roads

Little Thunder County Road connects with Highway 59 in sec. 2, T43N, R72W, and extends to the east approximately 12 miles where it turns southeast for approximately six miles (at this point it crosses 2.5 miles of the lease). From there it continues east to the paved Clareton Highway, 38 miles west of Newcastle. The Little Thunder County Road was graveled in 1971.

Reno County road connects with Highway 59 in sec. 35, T43N, R72W, and deadends at the Reno Livestock Company property. The Reno road is four miles south of the Kerr-McGee lease; it was graveled in 1972-73.

National Grassland roads

School Creek Road (#968) which was graveled in 1972 connects the Little Thunder and Reno County Roads three miles southeast of the lease.

There are a number of unimproved roads on the lease area that are used by ranchers to maintain fences and care for livestock. The location of these is not critical to the livestock operation as alternate routes can be used.

Powerlines

One 14.4 kv powerline crosses the lease area from northwest to southeast to serve ranch buildings in sec. 13, of T43N, R70W, and other ranches to the southeast. This line is owned by the Tri-County Electric Association. See transmission line map, Figure 83, Chapter IV, Part I.

Socio-Economic Conditions

The description of socio-economic effects of development is most significant at a regional level and is examined in Part I.

CHAPTER III

PROBABLE IMPACT OF PROPOSED ACTION

Development of the Kerr-McGee property will impact various environmental components. The impact analysis covers the entire area, an estimated 4,352 acres to be mined. Mine facilities will be constructed off of the leased area on private surface which has been purchased by Kerr-McGee. The impact of these facilities is discussed.

Construction of an access corridor involving a road, seven miles of spur rail line, and a transmission line into the ARCO area will be shared by Kerr-McGee. The impact of this access corridor was analyzed in Part III of this statement.

For purposes of this analysis, it was assumed that all the coal mined will be exported via railroad. Information as to the amount which may be committed to the coal slurry pipeline which has been proposed was not available at the time the analysis was prepared. The analysis does not cover the impact associated with the coal slurry pipeline. These impacts are in Part I. The impact of transportation of coal after it leaves the spur rail line is also covered in Part I of this statement. Impacts of offsite use of the exported coal is beyond the scope of this statement.

The impacts as analyzed here relate only to the mining operation. Cumulative regional impacts are discussed in Part I.

Air Quality

Mining of an estimated 300 million tons of coal over a total of 4,352 acres will create an impact on air quality for the expected life

of the mine, an estimated 22 years or until the year 1999. Mining is expected to begin in 1977 (1.2 million tons). Forty acres will be disturbed for the initial boxcut. Production will increase to 15.9 million tons per year in 1982 and is assumed to level off for the remainder of the mine life. At the 15.9-million-ton production level, an estimated 231 acres and 14 million cubic yards of overburden will be disturbed per year. Over the life of the mine, an estimated 270 million cubic yards of overburden will be removed and handled. Removal of vegetation and disturbance of topsoil and overburden will expose fine-grained soil and parent material to wind action which is frequently quite strong. Soil particles will be lifted by the wind and carried into the atmosphere, causing a reduction in air quality and reducing visibility during periods of high wind. Coal dust from crushers, trucks, coal piles, and loading operations will also pollute the air during the frequent, windy periods.

Emission from machinery, vehicles, and trains will add particulate matter and odor to the air on and adjacent to the mine site. The emissions as a result of train operations over this spur line are shown in Table 1.

Table 1

Train Emissions Resulting from Transporting
Kerr McGee Coal Production*

Year	Trains Per Year	Million Tons Per Year	Fuel Per Day-1,000 gals.	Emissions-Tons Per Year: Particulates	SO_2	NO_x	CO	Hc
1980	909**	10	12.1	55	126	820	288	208
1985	1,455***	16	19.8	90	206	1,336	469	340

*Emissions based on the maximum projected production of 10 million at 1980 and 15.9 million by 1982.
**909 loaded - 909 empty.
***1,455 loaded - 1,455 empty.

SO_2 - Sulfur Dioxide
NO_x - Nitrogen Oxides
CO - Carbon Monoxide
Hc - Hydrocarbons

Increased populations (1,550 by 1990) associated with the mine and its employees will generate increased vehicle traffic. Increased traffic, including commuting to work, will add additional emissions to the air and cause a further decrease in air quality. The cumulative impacts of this type of increase of emissions are discussed in Part I of this statement.

Increased mining and exposure of coal beds to the atmosphere will increase the chance of accidental coal fires. These will add particulate matter and other potentially toxic emissions to the atmosphere. Increased train traffic and people on the area also increase the possibility of wildfire. These would add to a temporary lowering of air quality by addition of smoke and particles to the air.

Inversion periods of two day duration can occur 15 times a year. These inversions will trap emissions. During inversion periods, respiratory conditions could be aggravated, asthmatics made worse, and lung diseases

caused or worsen. During normal weather conditions these pollutants will be carried downwind (to the east and southeast), dispersed, and diluted before reaching any population centers.

Reduction in air quality will begin in 1976, rise to a maximum in 1979, and then level off until the end of the mine life in the year 1999.

Topography

The factors that make mining economically feasible in the coal basin--thin overburden and thick coal--also cause a local topographic change. Removal of thick coal beds having little overburden for backfill creates a discrepancy between the volume of coal removed and the spoils returned to the mined area. Coal bed thicknesses in the mining area, excluding thin coal at the burnline, range from 60 to about 64 feet. Overburden thickness ranges from about 20 to 168 feet. The decrease in altitude over the lease area will range from a maximum of 54 to a minimum of 20 feet. The average drop in altitude for the entire area to be mined where the average coal thickness is 62 feet and the average overburden thickness is 88 feet will be about 44 feet. The maximum decrease in altitude will occur in the areas which have thick coal in relation to thin overburden.

The topography at the Jacobs Ranch mine before mining is shown on Figure 1. Mining will start at the west side and proceed northward from the suboutcrop or burnline in mile-wide panels. The topography after the removal of coal is shown in Figure 2. The model is based on mining 90 percent of the coal, expanding the overburden by 20 percent, mining a pit (panel) one mile wide, and returning or casting spoils 150 feet. Topography after mining could look surprisingly similar to the original topography. Topographic slope can be increased or decreased. The smoothing and rounding of the spoil piles generally tends to create a more subdued, rolling topographic relief. The postmining model shows many tiny hills and basins that probably can be smoothed in the reclamation process. Any cliff-like or abrupt topographic breaks now present on the area will be eliminated.

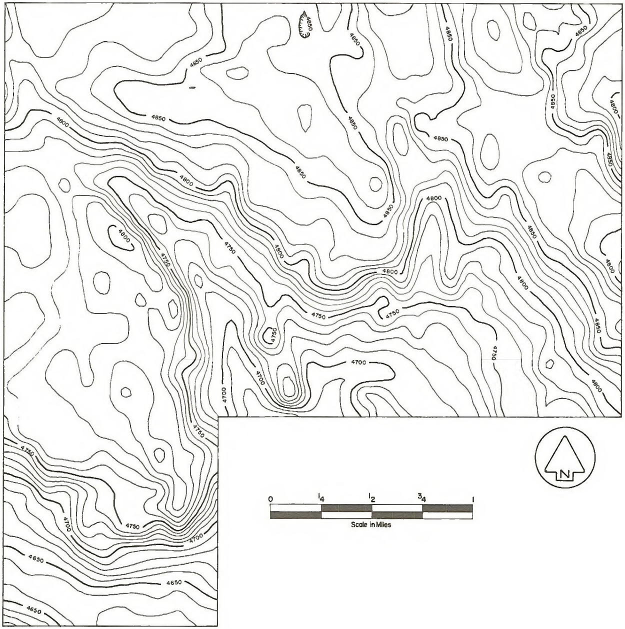


Figure 1

Topography at the Jacobs Ranch Mine Before Removal of Coal Showing Area to be Mined in 30 Years. Contour Interval is 10 Feet.

Figure 2

Topography of the Jacobs Ranch Mine After Removal of About 62 Feet of Coal. Contour Interval is 10 Feet.

North Prong Creek will be diverted and altered. Its present, steep-sided, meandering channel will be changed. The new channel of the creek may appear to be flatter and straighter after mining.

At completion of mining, the remains of the highwall will be visible on the north side of the mined area. The highwalls as illustrated in Figure 2 have not been reduced, but the pit may require a cut for drainage into North Prong Creek. This mine pit will create a long, narrow, trough-like depression and will probably be the most visible indication that the topography of the area has been altered.

Topographic impacts will occur slowly and may be noticeable in only a small portion of the mined area at any one time. Initially, the mining-reclamation model, including areas stripped, mined, rough and smoothed spoils and reseeded, will cover about 100 acres. This will increase to about 500 acres at the full annual rate of 15.9 million tons of coal. The shape of the landscape may change surprisingly little according to the mining-reclamation model. Until completion of mining, the most severe impact will be the highwall or active working mine face.

Soils

Mining of the area will result in the destruction and mixing together of all the existing soil types and horizons on all lands (4,352 acres) within the mine property. The degree of mixing and redistribution of the soils is unknown and will vary from place to place within the lease area. This will change all soil characteristics and destroy microorganisms and soil relationships which have been established over a long geologic time span.

In addition to the topsoil acreage which will be disturbed by mining, approximately 270 million cubic yards of overburden or lower soil horizons will be dug and disturbed during the 22-year life of the mine. This will result in complete destruction of all soil horizons and changes in soil characteristics. It could result in bringing material to the surface which may be toxic (boron) to plant growth. After mining, soil structure and properties will be completely different from those existing prior to mining.

These disturbances will result in fine-grained soil and parent material being exposed to wind and water actions. Soil permeability and infiltration rates may be reduced, increasing runoff, soil erosion, and sedimentation. Wind action, which is almost constant over the area, will cause fine soil, silt, and clay particles to be lifted into the atmosphere, reducing air quality and adding to soil loss. As all physical, chemical, and biological systems will be disrupted to an unknown degree, the overall result of mining action, undoubtedly, will be lowering of soil productivity.

Alteration of the channel of North Prong Creek could impact Little Thunder Creek downstream and adjoining land area. Channelizing stream

courses and releasing production waters, including mine drainage, may cause increased flow velocities resulting in accelerated erosion of stream beds and banks. This will increase the amount of soil loss in the immediate area as well as along downstream channels. Alteration of stream channels may deprive some areas of soil moisture, thereby affecting soil productivity and vegetative growth.

Construction of mine facilities on approximately 200 acres outside of the area to be mined will disturb and permanently remove the soil from productivity.

Additional offsite soil impacts will result from increased population associated with mine employment. Cumulative population increase is estimated to be 1,410 by 1980, 1,550 by 1985, and 1,550 by 1990 and would involve removal of an estimated 78 acres of soil from productivity by 1990. Increased recreation use, solid waste disposal, schools and other social facilities will create additional unquantifiable soil impacts such as compaction, erosion, and sedimentation.

Construction and mining equipment crossing undisturbed soil areas susceptible to compaction will reduce soil permeability and water infiltration rates. This will increase runoff, erosion, and sedimentation.

Mineral Resources

The most important impact is the one on coal. The removal and consumption of an estimated 300 million tons of coal from this area over the expected 22-year life of the mine will result in depletion of a nonrenewable energy source. The coal produced from this area will be exported to utility plants of Arkansas Power and Light Company and Gulf States Utilities.

Some coal will be lost from production in the mining process, mostly by leaving fenders of coal to block spoil piles from working faces. This loss of coal is temporary and the subsequent impact minor, as these fenders can be recovered before the pit is abandoned to spoils and waste.

Small amounts of sand and gravel beds potentially useful for aggregate occur on the lease area in the terraces and floodplains along North Prong Creek. Unless these sand and gravel deposits are removed prior to relocation of the streams and mining of the area, this resource will be lost. With the projected demand for this type of material as discussed in Chapter V, Part I of this statement, loss of any part of the sand and gravel resource locally could be critical.

The existing producing oil well in the area will be exhausted and abandoned before mine operations reach them. No impact on oil and gas rèsource is expected to occur. Oil and gas drilling can be resumed after mining is completed.

Water Resources

Ground water

During mining and reclamation

Mining of a total of 300 million tons of coal over the life of the project (22 years - 1999) and removal of 270 million cubic yards of overburden will destroy any aquifers located within the area. Disruption of aquifers would cause a cessation of flow and a draining of water into the pit. Pumping for dewatering during mining operations and for consumptive use will lower water levels to the base of the coal in the pit. The cone of depression from the point or points of pumping will extend outward an estimated four to six miles. At the outer edge of the cone, water levels will be lowered insignificantly. Within the area of influence caused by pumping, water levels will be lowered at increasing greater depths toward the mine area. Water wells that derive water from shallow aquifers within the area of greater drawdown could be affected. Springs and seeps in the major area of depression may also dry up. Where the aquifer is discharging into a stream, total flow could also be reduced. Reduction in water levels could impact agricultural use and wildlife populations.

No significant flow can be expected to occur between acquifers as a result of mining the coal; however, the removal of considerable overburden could have an affect on the artesian pressure in the underlying aquifers. Reduced overburden (removed load) could cause a movement of water upward in the underlying aquifers because the artesian pressure could respond to the reduced load and the potentiometric surface (pressure) would rise. Thus, the removed overburden could also result in an increase in water discharged into the mine pit.

The area to be mined is a ground water discharge area. Recharge to deposits involved with mining occurs west of the mine lease and this would not be impacted.

After reclamation

Replacement of spoils into the pit will result in deposits with reduced permeability. This reduction may result in less water flowing into the aquifer and increase surface runoff which could increase erosion and sedimentation. Although the overall altitude of the land could be reduced by 44 feet, this could result in less runoff in low areas where ponding may occur.

Surface water

Mining activities will destroy the existing drainage pattern in parts of the area. The channel of North Prong Creek will have to be diverted around the mine pit. The channelizing may decrease annual and low flows due to seepage loss to the pit. Peak flow will not be significantly affected unless protecting dikes break and the flow is diverted to the pit. Characteristics of the minor tributaries will be interruped by mining until reclamation is complete.

Channelizing stream courses may cause increased flow velocities and result in accelerated erosion of streambeds and banks. In changing the course of the stream, its base level may be lowered and result in headcutting of tributaries. Release of production waters, including mine drainage, would alter flow characteristics, possibly resulting in accelerated erosion of streambeds and banks. The amount of release would govern the extent of erosion in a downstream direction.

Water quality

Ground water

Since the mined area is a point of discharge, reduction of quality of water in the aquifers will not occur while mining is taking place.

After spoils have been returned to the pit leaching could occur and reduce the chemical quality of the water in the aquifers. This water would eventually move down gradient toward discharge points along Burning Coal Draw. Some discharge as seeps also might occur along North Prong Creek. The discharge of this water could result in lowering water quality in these streams.

Surface water

Erosion and sedimentation will be increased during construction and operation of the mine as vegetation is removed. High sediment yields will occur from spoil piles until they have been reclaimed and a protective grass cover established. Increased erosion and sedimentation could lead to a further lowering of water purity in the streams.

Dissolved solids will increase downstream from the proposed mining site during mining and reclamation, but changes in dissolved solids concentration will depend on the amount and concentration of water in receiving streams. Dissolved solids concentration in runoff from newly exposed surfaces will increase. Continuance of the increased dissolved solids loading in downstream waters after reclamation is completed will depend on the degree of success achieved in protecting exposed surfaces from leaching and erosion.

Increased population associated with mine development could affect water quality through recreational use of the area and from adding additional untreated sewage to the ground water. A trailer camp is proposed for Reno

Junction. Unless sewage from this area is properly treated, it may contaminate ground as well as surface water supplies.

Vegetation

During the 22-year life of the mine, vegetation will be destroyed on 4,352 acres. Vegetation will be removed progressively as mining proceeds across the lease area. Vegetation affected during this period is shown in Table 2.

Table 2

Vegetation Types and Amount to be Disturbed

Vegetative Type	Acres
Western Wheatgrass - Foxtail Barley	110
Western Wheatgrass - Slender Spike Rush	30
Inland Saltgrass - Western Wheat - Blue Grama	50
Blue Bunch Wheatgrass - Blue Grama	490
Big Sagebrush - Western Wheat - Blue Grama	950
Big Sagebrush - Needleandthread - Blue Grama	2,672
Big Sagebrush - Blue Grama	50
Total	4,352

Additional detail on vegetative type and relationships to be disturbed and destroyed is in Appendix D.

With initiation of coal production in 1977, some 40 acres of vegetation will be lost from the initial pit (boxcut), in the initial topsoil storage areas, and in spoil waste areas. This will accelerate up to 231 acres in 1982 when mining increases to 15.9 million tons per year. It is assumed that vegetative destruction will remain relatively constant from that point until the end of mining in 1999. After the first five years, equal areas will be reclaimed and disturbed, so at any one time after 1982, the amount of unvegetated area will be approximately 250 to 350 acres.

Construction of mine facilities outside of the area to be mined will permanently remove vegetation on an estimated 200 acres. Vegetative types removed will be inland saltgrass-western wheat-blue grama, big sagebrush-western wheat-blue grama, and big sagebrush-needleandthread-blue grama. The acreage of each type disturbed is not available because the location of plant facilities has not been determined.

Population increase associated with mine employment will remove an estimated 78 acres of vegetation by 1990. Vegetative types removed are indeterminable as location of population cannot be determined at this time. An additional indeterminable amount of vegetation will be disturbed or destroyed by development of social facilities (schools, solid waste disposal areas, etc.) to serve this increased population. Increased recreational use by the new expanded population, especially off-road vehicle use, will affect additional vegetative types and acreages within the total study area.

Haul road dust and fugitive coal dust from coal mining, blasting, transporting, processing, and loading on unit trains will be deposited on vegetation adjacent to the mine area. Toxic chemicals which could be present in the deposited dust may damage vegetation when wetted by dew and light rain. Dust-covered and damaged vegetation may be less palatable and possibly toxic to livestock and wildlife.

Suitable vegetation may be difficult or impossible to reestablish on some of the mined area. Toxic or nonproductive material may be brought to the surface; microclimate will be changed; soil structure will be destroyed with loss of some topsoil. These effects of mining may individually or in combination make revegetation difficult or impossible in some areas.

With the type of climate and existing soil types in the area, prediction of reclamation success is sketchy. However, an assumed reclamation success in this area is explained in Part I, Chapter III, Reclamation of Mined Lands.

Younger vegetation from the reclamation will attract wildlife which like to graze on young shoots. This grazing will inhibit early growth and revegetation of the disturbed areas.

Archeological and Paleontological Values

An archeological survey of the surface area has been conducted. The survey produced no evidence of major values in the lease area. (See Chapter II of this Part.)

With the unknown, below surface archeological-paleontological values, there could be significant impacts from strip mining. There will be nearly 4,352 acres involved in strip mining on this lease. Approximately 270 million cubic yards of overburden will be moved to mine the coal. Additional area will be occupied by facilities such as crushers, silos, railroad spurs, roads, offices, and equipment-maintenance buildings (200 acres). Moving the overburden or establishing permanent structures will either destroy potential archeological sites or make them unavailable for study and salvage.

Besides the direct impact of mining, there will be some indirect impacts associated with the population increase to be generated by construction and operation of the mine. Increased population will permanently remove and disturb additional acreage (78 acres by 1990) which could possibly contain archeological values.

Recreational use associated with this population will impact known as well as unknown archeological sites throughout the study area. Arrowhead hunters, rock collectors, pot hunters, and off-road vehicle users will all disturb additional acreage, destroying evidence which could provide information on archeological sites.

Historical Values

The Kerr-McGee Corporation has received a historical survey of the lease area, and historical values of only a community or local level have been identified on the lease. No state or even county significance is attached to any of these sites. However, if someone can place an important event or person at one of the sites later, the risk of losing the site will be ever present with the total destruction of the surface features.

Aesthetics

The impact on aesthetics will be gradual over time. Intrusions will be added to the landscape prior to and at the beginning of mining. Other changes will take place over a period of 22 years, the projected mine life. The changes to take place on this one site are not significant when compared to the 4.9-million-acre study area. However, the impact of mining on this specific site could be very significant when viewed against the surrounding natural landscape backdrop.

The mining operation will impact the existing landscape character by changing the form, line, color, and texture. Disturbance of vegetation, removal of overburden, and creation of new landforms cause a change in the appearance of the landscape, i.e., landscape character.

A color contrast will be evident where the mixed soil from the mine join the undisturbed natural soils and where the new vegetative cover on the reclaimed land meets the undisturbed sagebrush and grass.

Vegetation and landform will change from a coarser to a smoother texture due to reshaping to a smooth land form and a softer-textured vegetation. Eroded, rough, broken land will be graded to more gentle slopes. This will all result in less variety and natural configuration in the landscape, thereby reducing quality of the landscape character.

Intrusions such as roads, powerlines, railroads, pipelines, base area building, and other structures will add discordant character to the natural landscape character in form, color, line, and texture.

Other impacts on landscape character will be the general lowering of the profile in the mined area and the resultant highwall left at the edge

of the mining operation. Also, where the mining operation meets other mining leases, a discordant landform will result if the two are not coordinated and planned together at this point.

Wildlife and Fish

All wildlife will be displaced from the area as mining progresses. The smaller wildlife (reptiles, amphibians, invertebrates, rodents, and other burrowing animals) which are not able to flee will be destroyed. The populations which are displaced, such as the estimated 35 antelope, sage grouse, numerous birds, and small mammals, will have to relocate on adjacent sites. It is assumed that surrounding areas are already supporting populations in balance with available habitat. Therefore, displaced wildlife may exist for awhile, but the populations will eventually be lowered to remain in balance with the available habitat unless mitigating measures are taken. Part of the displaced population may eventually be lost.

Waterfowl which use small reservoirs during periods of migration will be forced to use other bodies of water in the vicinity.

The loss of wildlife habitat will be a constant progression across the mined property. Once full production of 15.9 million tons per year is reached by 1979, an estimated 231 acres of vegetation will be destroyed annually. By the end of the mine life, a total of 4,352 acres of habitat will have been destroyed. In all probability, the increased human activity and noise associated with mining operations will disturb and cause the major wildlife species to leave the area prior to destruction of the habitat.

The habitat for big game species (deer, antelope) and for sage grouse will be lost for a long period of time even though the area will be reclaimed. The projected time periods for return of the area to suitable habitat for various wildlife species groups is graphically shown in Figure 7, Chapter V, Part I, of this statement. Some of the animals, especially those associated with a grass habitat (Richardson's and thirteen-lined

ground squirrels, prairie dogs, mice and other small rodents), will return to the area as it is reclaimed and vegetation reestablished. No satisfactory evidence is presently available which would suggest that strip mined areas can be satisfactorily revegetated with plant communities that will satisfy needs for deer or antelope.

An estimated 278 acres of habitat, including that associated with construction of mine buildings and increased populations will be permanently lost. This will involve an indeterminable loss of various animal species. Increased recreation use will remove additional acres of habitat and increase pressure on wildlife populations by disturbance and displacement.

Increased vehicular use on the area and on surrounding roads will increase animal road mortality. Mortality will also occur from train traffic. Construction of right-of-way fences and fences to protect the reclaimed area to allow for revegetation may cause some impact on wildlife movement and migration. The greatest impact of fences will likely be on antelope, and any east-west fencing will be most restrictive to their present seasonal movements.

The noise and human activity associated with this mining operation may impact the elk herd usually located to the east of the leased area. Elk in this type of habitat do not normally tolerate excessive human activity or noise. They may be forced out of their present habitat which could in the long run result in their elimination.

Some food chains will be disrupted when habitat is lost, but it is difficult to estimate the species or the amounts of the smaller animals and the effects on each.

Recreation

The proposed mining operation will disrupt present patterns of recreation activities on the lease and adjacent areas.

The mining operation and base plant site will eliminate approximately 500 acres of hunting area on an annual basis throughout the life of the mining lease. This will affect approximately 10 visitor days of use per year.

Improved access will be available for recreation activities. Hunting can be expected to increase due to better access and increased human population. Elimination of vegetation and reduction of wildlife habitat and populations could affect hunting quality on and adjacent to the mine property.

Other activities can be expected to increase except for artifact hunting which will be slowly eliminated as the mining progresses. Sightseeing will definitely increase because of the interest in the mining activity and the desire to capture it on file.

Agriculture

Livestock forage

Grazing on the entire 4,352 acres of the mine area will be disrupted by the end of the mine life in 1999. A total of 1,088 AUMs (animal unit months) of animal production will be affected. The disruption will occur over time. Construction of mine plant facilities will disturb an additional 200 acres and 50 AUMs of forage production.

Of the total area disturbed, an estimated 200 acres (50 AUMs) will be permanently removed from production. This area will be utilized by mine facilities. Livestock management facilities which will be destroyed include: 12-1/2 miles of fences, five stock water dams, numerous spreader dams, and two water wells.

The ranchers presently using this area will be affected to an unknown extent. A major portion of the area is owned and utilized by Jacobs Land & Livestock which is a subsidiary of Kerr-McGee. Once mining is completed, it plans on continued utilization of the area for grazing purposes.

Transportation Networks

There will be 2-1/2 miles of Little Thunder Road and a number of unimproved dirt roads destroyed as mining reaches them. These roads are used by ranchers for access to cattle pastures and by hunters for access. Loss of these roads will cause an inconvenience to these users by requiring them to travel somewhat further. There are a number of other roads that may be used when the above roads are destroyed.

The existing 14.4 kv powerline will have to be moved as mining operations reach the area it crosses. There should be no impact on power users.

Increased traffic created by population growth and employment at the mine may increase road congestion and hasten deterioration. Without knowing where the population will settle, identification of which roads will receive this increased use is not possible.

Socio-Economic Conditions

The primary socio-economic impacts will be those associated with increases in capital expenditures, employment, population, and income.

Estimated capital expenditure at the mine will be 58 million dollars. Construction of the mine site will employ 200 people for about 1-1/2 years. These people and their families will probably live in a trailer camp to be established near Reno Junction.

The following table shows estimates of employment, population, and wages induced by the mine. An average annual income of $15,230 per employee in 1975 is expected.

Table 3

Estimated Employment, Population and Wages Induced by the Jacobs Ranch Mine

	1975	1980	1985	1990
Mine Employment	175	200	225	225
Other Employment	350	400	450	450
Total Population	1,260	1,410	1,550	1,550
Wages from Mine Employment only*	2,665,250	3,887,400	5,581,800	7,123,950

*Assume inflation = 5 percent per year.

The mine operation will continue until the year 1999. Population growth will increase the demand for services, protection, water supplies, sewage disposal facilities, and housing. Problems associated with more dense populations such as crime, mental illness, and unemployment will probably increase. These impacts are discussed in Part I.

CHAPTER IV

MITIGATING MEASURES

Air Quality

All activities affecting air quality must comply with state and federal air quality laws as listed in Part I.

Primary mitigating measures will be dust and emission controls. Dust from denuded areas and roads will be minimized by reclaiming spoil piles as soon as possible after mining, treating roads to reduce dust, irrigating areas to hold dust on the ground and hasten revegetation, and placing chemical or physical covers over exposed areas to prevent dust from lifting into the air. Coal piles should be minimized by shipping coal as soon as possible and limiting storage onsite. This will reduce the chance of high winds blowing coal dust and reduce the opportunity for coal to burn onsite. Emission control devices will be used to reduce gaseous and particulate matter from vehicles, processing plants, and heating plants.

State, federal, and industrial fire prevention campaigns will reduce the number of fires. The construction of firebreaks along roads and railroads and around mining activities will limit the extent of fires. Fire fighting equipment will be required on the site. The use of spark arrestors on equipment will cut down on accidental range fires. On turbo-charged equipment and locomotives which cannot use spark arrestors, use of a high quality diesel fuel will minimize sparks.

Topography

The mining and reclamation plan filed with the Federal Government, in conjunction with federal regulations, state laws, and the coal lease terms, requires action to mitigate the adverse topographic effects of surface mining. Spoils will be graded to a rolling topography, with no slopes steeper than 3:1. Highwalls will be reduced and final pits will be filled with material from adjacent spoil banks and highwalls. The spoil banks, highwalls, and final cuts will then be covered with a layer of soil material to facilitate revegetation. All exposed coalbeds will also be covered by at least three feet of soil material.

The restored land form will be determined by consultations among the lessee, appropriate land management agency, the State Department of Environmental Quality, and the U. S. Geological Survey. Consultations will be frequent enough so as not to impede the progress of the mining or reclamation. Prime consideration in grading and shaping shall be the catching and holding of any waters falling on the area to improve the water table and catch and hold sediment in such a manner as to protect downstream areas.

Surface water may accumulate selenium, arsenic and other toxic elements including deleterious salts which become concentrated and deposited along the shore due to evaporation of closed water bodies. Therefore, during the shaping of the spoil into the final landform no closed interior ponds should be permitted.

Soils

The land will be reformed following mining and construction activity to facilitate proper revegetation. Topsoil will be stockpiled during the mining operation and replaced on the reformed land prior to revegetation. Mechanized equipment, such as scrapers, which will minimize soil mixing will be used for both stockpiling and replacing topsoil.

Productive soil will not be buried or mixed with unproductive or toxic material. Toxic or other undesirable material will be buried below the top 60 inches.

Soil erosion will be minimized by structures such as waterbars, terraces, contour furrows, etc. Soil compaction will be mitigated by restricting off-road vehicle use and by ripping and tilling. Soil stability will be insured by revegetating the disturbed areas or by insuring proper protective measures if other higher uses are made of the lands.

The leasee will provide the Forest Service detailed soils information on the mining area to supplement information now available, and to insure that the above measures will be accomplished. This information will include:

1) A detailed soils map of the lease area to standards designated by the Forest Service.
2) Analyses of samples of soil from soil horizons and overburden formations down to coal seam to determine presence or absence of toxic or undesirable material, their depths and thicknesses.
3) Determination of soil moisture relationships.

4) Detail analyses, physical, chemical and mechanical characteristics of soils after replacement and prior to revegetation.

   (a) Soils map characterizing the upper 60 inches.

   (b) Chemicals analysis of the top 60 inches.

   (c) Conduct mechanical analysis of the upper 60 inches.

   (d) Determine soil mineralogy of the upper 60 inches.

Water Resources

Availability of water from deeper aquifers

Water-well supplies affected by lowered water levels in the radius influenced by dewatering for mining could be replaced by deeper wells. The chemical quality of water in the Fort Union Formation is similar to or better than that in the overlying Wasatch Formation.

Monitoring programs

Monitoring programs are being established by companies planning to mine coal. A number of the monitoring programs are being planned in consultation with the Water Resources Division of the U. S. Geological Survey. The programs consist of establishing observation wells to determine water-level fluctuations in coal and overlying overburden. Water samples will be collected to determine chemical quality of the water and for detecting changes in water quality after mining begins. As mining progresses, observation wells will be established in backfill areas to monitor for leaching and movement of toxic materials.

Vegetation

Loss of vegetation will be mitigated by satisfactory revegetation. Initial measures will be started within one year following reshaping of the land and replacing of the topsoil. Revegetation efforts will continue until a satisfactory stand of grasses, shrubs or trees of acceptable species is established and free to grow without irrigation.

Plans to revegetate disturbed land will be approved by the surface owner. On the National Grasslands one of the following five options, or combinations thereof, will be used.

1. Plant the reclaimed area with native species only.
2. Plant a mixture of native and introduced species of grasses and shrubs.
3. Plant native grasses, shrubs, and shelterbelts using mine water, treated as required, to maintain shelterbelts.
4. Plant only introduced species.
5. Plant species adaptable to new landforms, natural lakes and reservoirs.

Following are examples of vegetative species which may be used. Numbers refer to above options for which that species is appropriate.

1,2,3 Blue Grama (*Boutelous gracilis*)

1,2,3,5 Needleandthread (*Stipa comata*)

1,2,3,5 Western Wheatgrass (*Agropyron smithii*)

1,2 Sandberg Bluegrass (*Poa sandbergii*)

Threadleaf Sedge (seed not available)

1,2 Greenneedle Grass (*Stipa viridula*)

2,3,4,5 Slender Wheatgrass (*Agropyron trachycaulum*)

2,3,5 Rabbitbrush (*Chrysothamus viscidiflorus*)

2,3,4,5 Winterfat (*Eurotia lanata*)

2,3,5 Big Sagebrush (*Artemisia tridentata*)

2,3,4,5 Yellow Sweet Clover

2,3,4 Crested Wheatgrass (*Agropyron cristatum*)

2,3,4,5 Sodar Streambank Wheatgrass

2,3,4 Fall Rye, Oats, Barley Wheat

3,4,5 Russian Olive

1,3,5 Plains Cottonwood

3,4 Caragana

3 Yellow Pine

3 Juniper

3,4 Hackberry

5 Willow (peach leaf)

5 Hard Stem Bullrush

5 Cattails

5 Deep Water Duck Potato

3,5 Wild Duck Millet

3,5 Reed Canary Grass

5 Sago Pondweed

Specific revegetation measures will be recommended by the lessee in the mining and reclamation plan, for approval by the Forest Service. When planning and approving revegetation, the lessee and the Forest Service will consider and use supplemental measures to aid revegetation when needed such as irrigation, including treating water as necessary, fertilization,

soil amendments, tillage, mulching, and the correct time of year to seed or plant.

Research studies will be planned and implemented to determine the effect of industrial emissions and dust on plants and animals.

Reclamation plans will recognize the effects of landform, vegetation, soil color, and soil texture on the microclimate. The mining and reclamation plan will consider modifying the landform to provide a microclimate favorable to revegetation. Such landform modifications may include terraces, contours, minimizing the area in south facing slopes or other ideas which evolve during the course of the reclamation job.

The lessee will be responsible for the continued management of rehabilitated areas, including fencing which may be necessary to control use by livestock and wildlife, until the vegetation is satisfactorily reestablished.

The use of herbicides and soil sterilants in maintenance of rights-of-way will be controlled by applicable federal and state laws, and requirements of the surface owner.

Archeological Preservation

Legislative authorities and obligations which guide issuance of federal license to develop the Powder River coal resources are the statute commonly referred to as Antiquities Act of 1906 (34 Stat. 225, 16 U.S.C. 431-433); Wyoming statutes relating to archeological and paleontological sites (sections 36-11 to 56-13 and 18-330.7 W.S. 1957); an act for salvage at reservoir sites (74 Stat. 220; 16 U.S.C. 469-469c); an act for historic preservation (80 Stat. 915, 16 U.S.C. 470-470m); National Environmental Policy Act of 1969 (83 Stat. 852, 42 U.S.C. 4321 et seq); and Executive Order 11593, May 13, 1971 (36 F.R.-8921).

Both federal and state antiquities acts regulate antiquities excavation and collections, and both protect historical values on public lands. They provide for fine and/or imprisonment for violators of their provisions. The reservoir salvage act provides for recovery of historical and archeological data from areas to be inundated by certain water impoundment, as a result of federal action. The Historic Preservation Act established a system of historic preservation in the nation and requires that certain federal undertakings be submitted for review by the National Advisory Council on Historic Preservation. NEPA states in Section 101(b)(4) that one objective of national environmental policy is to "preserve important historic cultural and natural aspects of our national heritage and maintain, wherever possible, an environment which supports diversity and variety of individual choice." Finally, Executive Order 11593 affects federal agencies most intimately in that they are instructed to cooperate with the nonfederal agencies, groups, and individuals and to insure that federal plans and programs contribute to the preservation and enhancement of nonfederally owned historic and cultural

values. Agencies are directed to inventory, evaluate and nominate properties in their jurisdiction to the National Register of Historic Places.

Under the mandate of the Executive Order, federal agencies must insure that until inventories and evaluations are completed, the agencies will use caution to assure that federally owned properties which might qualify for nomination to the National Register of Historic Places are not inadvertently transferred, sold, demolished or substantially altered and that federal plans and programs contribute to the preservation and enhancement of non-federally owned sites.

The Antiquities Act of 1906 prohibits damage or excavation of plant and animal antiquities on federal lands without a permit (see 43 CFR Part 3). The Wyoming statutes require that permits be obtained before excavation on any archeological or paleontological deposits on either state or federal public lands (sec. 36-11 W.S. 1957).

Archeological and paleontological values on federal lands will be protected by surveys and salvage excavations. Federal ownership of the subsurface estate extends similar protection to the federal holdings underlying privately owned surfaces. The Wyoming Antiquities Act similarly requires a permit for excavation of antiquities on public lands, permission to be granted by the State Board of Land Commissioners.

Surface surveys for evidence of archeological values in the alluvium are fundamental to establishing responsible stipulations for their protection. Therefore these stipulations in the mining plan and/or permit that require surveys will be followed to insure archeological and paleontological protection.

No mining plans or rights-of-way will be approved until the company has coordinated its archeological surveys with the Wyoming State Historic Preservation Officer (State Archeologist). Company survey reports will be submitted to the State Historic Preservation Officer with a copy to agencies approving plans and permits. The report will be certified by the Preservation Officer and forwarded to the approving agencies, with a statement that surveys have been conducted by competent, professional archeologists and a recommendation for additional surveys to be required before plans and permits are approved. These additional surveys may be necessary if surface evidence indicates further evaluation is necessary. In addition approvals will be conditioned to require notification to the Area Mining Supervisor of all archeological and paleontological sites discovered during mining prior to disturbance and notification to the appropriate officer of the surface administrating agency of sites discovered during right-of-way construction prior to disturbance. The Antiquities Act of 1906 and Wyoming statutes make it unlawful to excavate sites which are discovered without a permit.

Furthermore, it will be required that the alluvium to be displaced during the mining operation be surveyed and that all surveys be coordinated with the Wyoming Historic Preservation Officer to insure competent, professional inventories, salvage and preservation of archeological and paleontological data.

It is recommended that all present and future applicants share in the cost of establishing a full-time resident basin paleo-archeologist under the supervision of the State Historic Preservation Officer. The basin archeologist will aid in reducing lead time and development delays performing, advance surveys for support facilities, educating construction employees, sampling soils, responding to company discoveries and conducting salvage work.

Historical Values

The historical value survey has been conducted for the lease area, and data has been extracted for the known sites. However, according to the State Historian, the possibility always exists that new information may be discovered that could place value on a previously unimportant site. If this occurs, the appropriate acts shall be used to determine the course of action of the agency having jurisdiction over the land.

Aesthetics

The objectives for aesthetics is to blend mined-out areas to the existing landscape to the extent possible. This means that colors, form, lines, and textures should correspond. An exception to this is water features. Water features add interest to a landscape giving it variety.

The annual operating plan of the Kerr-McGee mine will be approved by the Forest Service. The following mitigating measures will be required for aesthetic consideration.

The proposed mining plan now states that the topsoil will be stripped off and replaced on the reshaped landform. This will reduce or eliminate the color contrast that would otherwise occur.

Landform cannot be restored to the original contour and configuration, but the reshaped land will be blended to the undisturbed land to reduce or eliminate contrast in form, line, and textures. In other words, smooth terrain will join smooth terrain and rough terrain will join rough terrain so that a gradual blending with the adjacent natural areas will take place.

Color, line and texture contrast in vegetative changes will be reduced or eliminated by using a mixture of native species including sagebrush on the rehabilitated areas. On pipeline rights-of-way where long straight segments usually occur the line dominance will be reduced by planting sagebrush on the right-of-way. Additional clearings in irregular patterns will be planted to grass to reduce the line dominance of pipeline rights-of-way.

Structures will be kept as low as possible on the skyline. They can be placed in natural depressions and telephone lines and low voltage power lines can be buried.

Wildlife

The primary impact of habitat loss will be mitigated by increasing wildlife carrying capacity on areas adjacent to the lease. This will be accomplished prior to mining by measures such as providing wildlife cover, improving vegetative species composition and providing water developments.

Industry will provide detailed ecological information on present animal populations such as composition, movements, habitat and food chains to support rehabilitation plans and the selection of alternate habitat areas.

Under the direction of the Wyoming Game and Fish Department, wildlife species important to the area's economy, recreation or critical food chains will be captured and moved to new locations, if the animals do not move of their own accord. Such species may include antelope, grouse, rabbits, ducks, geese, and other game animals and birds.

Wildlife habitat will be considered in reclamation measures following mining and will be coordinated by the surface owner with the Wyoming Game and Fish Department.

Measures that should be taken to restore the wildlife habitat include the following: sagebrush, rabbitbrush, winterfat and early season grasses in restoration plantings to benefit antelope and sage grouse. Include additional shrubs suited to the area for cover when deer habitat is involved. Plant and protect aquatic and emergent vegetation in reestablished water developments.

The primary mitigating measures for recreation will be prompt reclamation to retain aesthetic and wildlife values. These are discussed in the soil and vegetation sections of this chapter.

Agriculture

Existing fences, water wells and reservoirs will be replaced after reclamation to the extent and in locations which will assure optimum grazing use of reclaimed land. Industry will reimburse individuals and public agencies for any facilities which cannot be replaced due to mining and related development.

The impact of grazing loss, both temporary and permanent, will be mitigated. For example, more intensive grazing on or adjacent to the lease area could be accommodated by improving species composition, increasing water developments, fencing and sagebrush eradication. Portions of the lease area should be grazed until mining actually occurs and prompt reclamation will bring mined land back into production as quickly as possible.

Utilities and transportation facilities serving the area will be placed in corridors on National Grasslands to localize and minimize the area removed from production. Processing plants and buildings should also be designed to use a minimum surface area.

Transportation

A long range transportation plan including road design and location should be developed by industry, county, state and federal agencies to meet the needs now and in the future.

On National Grasslands, corridors will be designated for construction of facilities (roads, powerlines, etc.) to reduce the impacts on other uses. The corridors have not been located and evaluated.

CHAPTER V

PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Air Quality

Adverse impacts on air quality, resulting from development of the Kerr-McGee mine property cannot be avoided. Some coal and soil dust created by mining 300 million tons of coal, disturbing a total of 4,352 acres over the 22 year period will occur. About 231 surface acres will be disturbed in any one year and 500 acres may be bare at any one time.

Even with proper emission controls, emissions from vehicles, equipment and accidental fires will occur causing a reduction in air quality on the lease site and downwind. As there are no effective emission controls for diesel locomotives, emissions from train operations cannot be avoided. These emissions are expected to reach a peak by 1985 and remain fairly constant thereafter. Table 1 compares the projected unavoidable train emissions with the 1970 quantities for the Wyoming Intrastate air quality control region.

Table 1

Unavoidable Train Emissions Versus 1970 Total Emission For
(Tons/Year)

Type	1970 Base	1980 Increase*	1980 % Increase	1990 Increase*	1990 % Increase
Particulates	26,510	26,565	2%	26,600	3%
Sulfur Dioxide	38,202	38,328	.3%	38,408	.5%
Nitrogen Goxides	28,647	29,467	2.9%	29,983	4.7%
Carbon Monoxide	122,428	122,716	.2%	122,897	.4%
Hydrocarbons	21,635	21,843	1.0%	21,975	1.6%

*Base plus train emissions

Topography

A reduction in altitude caused by mining thick beds of coal with thin overburden cannot be avoided. The decrease in altitude over the lease area will range from a maximum of 54 feet to a minimum of 20 feet. The

Destruction of natural features of the landscape is unavoidable. Even though the general topography of the area can be restored at a lower level, cliffs and abrupt breaks, presently a part of the topographic scene cannot be restored. The exact slope and angle of the present topography is unrestorable.

Change in the drainage channel of North Prong Creek cannot be avoided.

Soils

Disturbance of topsoil on a total of 4,630 acres (4,352 mined - 200 mine facilities - 78 housing) cannot be avoided. Loss from productivity of 278 acres of soil (mine facilities - housing) is unavoidable. The disturbance of topsoil will lower to some degree, the natural soil productivity of the area by compaction, mixing natural soils and causing accelerated soil erosion.

On the area to be mined, 4,352 acres, the complete destruction of all soil horizons parent material and soil characteristics which have developed over long periods of geologic time, cannot be avoided. The present soil biota and soil forming processes will be terminated. Once mining is completed and the area reclaimed, soil development will have to start again. As an end result, new soils will be formed with characteristics totally unlike the ones existing prior to mining.

Reduction of soil productivity, permeability and infiltration rates are unavoidable. Increase in erosion and sedimentation rates will occur, but the amount of soil loss through time cannot be determined.

Mineral Resources

Mining and removal of coal cannot be avoided under present plans and proposals. Thus, the proposed mining activity will have an unavoidable adverse effect on the coalbeds, coal resources, and coal reserves in that deposits of a nonrenewable mineral commodity will be depleted. Based on company plans, an estimated 300 million tons of coal will have been mined by 1999 which comprises 2.4 percent of the estimated economically recoverable strippable coal reserves thus far identified in Campbell and Converse Counties. Loss of minor amounts of coal in mining, loading, and transportation operations is unavoidable.

Water Resources

The amount of water consumed in mine operations will be unavoidably lost. The amount cannot be quantified. Aquifers removed by mining will be permanently lost. However, the effect of this loss will be local.

If the final pit is left as a pond it may deplete streamflows and will add to evaporational loss of water which then is not available for other uses (agriculture - stream habitat).

A reduction in water quality from increased erosion and sedimentation will occur to some degree. The amount or degree cannot be estimated.

Vegetation

Vegetation will be temporarily destroyed on 4,352 acres and permanently removed on 278 acres. These losses associated with mine operations, and increased population cannot be avoided.

All plant succession is unavoidably destroyed at the time of disturbance. Fifty years or more of plant succession will be required for these areas to return to their present state as existing soil structure and micro-climate have been changed and altered.

Even on areas that are successfully reclaimed, a 50 percent loss in productivity has been projected.

Archeological and Paleontological Values

Subsurface material and sites will be damaged or destroyed under the most responsible mining program, with much more lost to indifference from surface activities of population expansion.

Some losses, removal of 78 acres to regional expansion will be expected from lack of surface evidence, time, money, and trained personnel to conduct regional surveys.

Limiting interpretive and educational material on the collected data will contribute to uniformed damages by construction activities and regional residents.

Aesthetics

The added structures, roads, rail lines, powerlines will be discordant intrusions added to the natural landscape. The natural landscape (shape-texture-color) will be changed unavoidably. To some, this will be an adverse alteration of the natural landscape.

Even after reclamation, the disturbed areas will be discernible for a long period of time.

Wildlife and Fish

Loss of habitat and reduction in population will occur. The smaller wildlife (reptiles, amphibians, invertebrates, rodents, and other burrowing animals) which cannot flee will be destroyed. An estimated 35 antelope and 35 sage grouse will be displaced, or ultimately lost.

Destruction of 4,352 acres of habitat will reduce the carrying capacity of wildlife habitat in this area. Successful return of wildlife habitat for most animals will require a period of from 20 to 50 years. (Figure 7, Chapter V, Part I). The permanent removal of 278 acres of habitat will be unavoidable.

Increased population will intensify recreational use of the area. This will adversely impact additional wildlife habitat. Intensified use may also adversely affect the elk herd east of the lease area. The disturbance may cause the elk herd to move to unsuitable habitat, resulting in an unavoidable loss of the entire herd.

Recreation

Loss of an estimated 10 visitor days of use per year and 500 acres of hunting area on an annual basis cannot be avoided.

Reduction of wildlife habitat, population, and quality will lessen hunter opportunities. Increased population will intensify recreational use, which could cause adverse reduction of recreation quality and deterioration of facilities.

Agriculture

Permanent loss of 200 acres of forage and 50 AUMs cannot be avoided. Destruction of five stock water dams, and two water wells is unavoidable on site though they may be replaced in kind at other locations. Reduction of livestock water will result in a loss of grazing capacity.

Temporary loss of forage during mining operations cannot be avoided. Reduction of an estimated 50 percent in carrying capacity after reclamation cannot be avoided. This will cause an annual overall yearly loss of 544 AUMs, assuming the entire area will be successfully revegetated.

Destruction of grazing pastures (4,352 acres) and the necessity of the rancher having to provide pasture elsewhere is unavoidable. The added economic cost of having to provide new water sources for livestock cannot be avoided.

Transportation Networks

Increased traffic on all existing facilities cannot be avoided. The increase will begin in 1976. Road maintenance costs and frequency will increase and these costs cannot be avoided.

Temporary inconvenience and poor travel conditions caused during construction of such facilities as the access road, and transmission line are unavoidable. These impacts will be minor and occur only over a short time span. With the number of trains required per day (8 by 1985), the increase probability of these accidents occurring cannot be avoided.

Relocation of the oil and gas pipeline across the area will occur. Some disruption of service could occur and be unavoidable. Rupture of these lines during mining could cause serious adverse unavoidable impacts on water quality, wildlife, and vegetation.

Socio- Economic Conditions

Unavoidable adverse effects of this mine cannot be quantified at this level. The cumulative impacts are analyzed in Chapter VII, Part I.

CHAPTER VI

ALTERNATIVES TO THE PROPOSED ACTION

Approve the Mining Plan After Modification

Some of the impacts identified and discussed in Chapter V could be avoided if the mining plan were modified to require the use of one or more of the operational alternatives discussed below. In addition, special conditions could be added to the plan relating to secondary effects of the mining. Such conditions must be reasonable and, if unacceptable to the lessee, could result in the lessee not developing the area with the resultant impacts discussed under the heading "No New Development of Coal and Alternate Reclamation Objectives" in the Regional Report (Part I, Chapter VIII).

Different methods of mining

Underground mining

Substitution of this method of mining would result in less initial disturbance of the land surface; greater costs because underground mining would be more costly than surface mining; a decrease in mine safety as indicated by the fatal accident rates in 1972 of 0.42 per million tons mined underground compared to 0.07 per million tons for surface mining; and higher incidence of non-fatal accidents due to roof and coal falls, fires, explosions, and problems related to dust inhalation (black lung disease).

On Kerr-McGee's federal leasehold, the coalbed averages 62 feet in thickness. Assuming that a 10-foot section could be mined safely by underground methods and that 50 percent of coal in the mined area were left in place

to provide support and lessen the probability of surface subsidence, coal extracted would represent about 8 percent of the available coal in place. This rate compares to an expected recovery of 90 to 95 percent of the available coal in place using surface mining methods.

In-Situ Production

Techniques for the economical burning of coal in-situ and capture of the released volatile gases are still in experimental stages. Present knowledge indicates that energy recovery levels of in-situ production are low and amount of surface subsidence in areas of thin overburden is highly unpredictable. Impacts associated with in-situ production would include the possibility of destruction of a coalbed aquifer, pollution of ground water, and air pollution from escaping gases.

For in-situ production to be a viable alternative technique, methods for increased recovery of volatile gases must be developed. Such increases could then allow in-situ production to compare favorably with the high recovery of coal by surface mining methods.

Auger mining

Auger mining should probably not be considered as a realistic or viable alternative to surface mining because it is not used except under specific conditions. Auger mining is used to recover coal along a highwall of an existing surface mine which has reached its maximum overburden limits. The effective penetration depth is limited to less than 200 feet and the auger diameter is presently limited to 84 inches. In beds less than 7 feet thick, recovery is less than 40 percent and would be considerably less for Kerr-McGee's

62-foot total coal thickness. Auger mining is not applicable on Kerr-McGee's leasehold to sufficiently supply the quantities of coal demanded.

Different rate of production

The Kerr-McGee Corporation has contracts to supply coal to power plants in Arkansas and Louisiana at a yearly rate of 1.2 million tons in 1977 escalating to 15.9 million tons in 1982.

Any change in production rate, either upward or downward, would alter the rate or intensity of the environmental impacts discussed previously in this statement. If a reduction in proposed production were required, it would create a shortage of fuel at the power plants in the area of consumption and result in decreased power production when consumption is increasing unless substitute sources of supply were obtained. A reduction would also prolong mining activity on the leasehold, prolong the time until restoration is completed, lessen employment at the mine, lessen the acreage disturbed at any one time, and lessen annual tax and royalty returns to the state and county.

If the company were required to increase production above the level proposed, it would cause storage problems, with the possibility of fires in storage areas, unless additional new markets were found, increase the intensity and severity of the impacts described elsewhere in the statement, decrease the length of time for mining and reclamation, and increase annual tax and royalty returns.

Different utilization

Onsite power generation

Transportation and fuel costs for onsite electric power generation would be minimal and there would be less chance for coal spilling than during

transportation to offsite power generation plants. However, a coal burning electrical power generation plant would have to be constructed, transmission lines would have to be built, and the generating plant would have to be connected into the existing power distribution network.

For a water-cooled plant large volumes of water and water rights would have to be obtained and pipelines and storage facilities built to supply an onsite steam generating plant. The electrical stations in the area of consumption would lose the supply of coal for which they were designed unless coal of like quality from another mine in the area was substituted for coal from the Jacobs Ranch mine.

The local environmental impacts that would result from onsite power generation would be degradation of air quality by stack emissions; noise from the generating station, the large quantity of water needed must be diverted from other uses; degradation of scenery by the generating station, transmission lines, and support facilities; dust related to coal handling, processing, and ash disposal; loss of land used by the generating station and support facilities from other uses; and increased employment and related economic benefits. Impacts associated with mining and reclamation would remain the same.

Other offsite markets

To supply coal to other offsite electrical power generating plants would have the effect of transferring transportation and other end-use impacts elsewhere. These impacts have been described heretofore in the statement. The impacts associated with mining and reclamation would remain the same if the proposed production rate was not increased. If increased, the severity and duration of these would also be increased.

Different methods of coal transport to the proposed railroad

Pipeline transportation

Transporting coal in a pipeline as a slurry could be required as a possible alternative. An advantage would be less surface pollution by wind-blown or spilled coal from railroad cars. The time and capital cost of planning and constructing a pipeline from the Jacobs Ranch mine to the proposed main line railroad is unknown. Based on the Black Mesa pipeline, however, the cost would be in excess of $128,000 per mile (Love 1969).

Impacts of this alternative, in addition to cost would be:

(1) Acquisition of a pipeline right-of-way to the proposed railroad at least 75 feet in width, including land for support facilities;

(2) Require obtaining of rights for a large volume of water necessary to operate the slurry pipeline;

(3) Necessitate the construction of storage facilities which would require land use change and surface disturbance at locations along the right-of-way;

(4) Additional construction of processing facilities for coal slurry preparations and dewatering facilities would be necessary;

(5) Pipeline construction would also require a large quantity of steel pipe which would be lost to other uses.

(6) A large amount of energy would be lost to other uses during construction and operation of the slurry pipeline;

(7) Spillage of coal slurry due to pipeline ruptures would degrade local areas;

(8) Supplemental railroad hauling of slurried coal would require construction of facilities to remove wet or frozen coal from railroad cars.

Highway transportation

Substitution of truck haul for railroad haul would not cause additional surface disturbance at the proposed mine. Existing county and state roads would have to be redesigned and rebuilt to withstand the stress of constant coal-loaded truck traffic. The large number of trucks would create increased noise, pollution from truck emissions, and increased safety hazards for the public.

Reject Mining Plan

Rejection of the Kerr-McGee mining plan would result in no environmental impact on the leased lands, and they would continue in their present condition or be modified by the surface owner to meet other uses. The Kerr-McGee Corporation could submit a new mining plan, challenge the rejection, or abandon--at least temporarily--development of the lease. Should the mining plan be rejected, the development of alternate sources of energy or a reduction of energy consumption would be necessary.

Kerr-McGee may also begin mining operation on its holdings of state or privately owned coal in the same locality with the same primary and secondary impacts as those evolving from the mining of both federal and private coal. Such mining would result in a number of small mines in the privately owned lands, leaving the federal coal untouched. Such a pattern, where federally owned coal is not mined, would increase extraction costs; create an indeterminable number of small, isolated strip mines on privately owned coal lands; result in increased mining problems and costs if the federally owned coal were later extracted; and result in a loss to the state and county of taxes and a loss of the state's share of revenue distributed in accordance with the Mineral Leasing Act. In addition, reclamation and enforcement requirements under state laws could be less stringent than those required by the Federal Government, thereby affecting the restoration of mined areas.

In the event Kerr-McGee chose not to mine on privately owned land as a consequence of rejection of a mining plan on the federal leasehold, coal for the power plants to be supplied would have to be obtained from another source.

CHAPTER VII

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Mining will result in the introduction of new roads, buildings, trackage, powerlines, and heavy equipment into an area not appreciably changed from its natural state except by an electrical transmission line, a county road and the attendant structures associated with grazing and farming activities.

The lease area will be committed to coal production for a period of about 22 years, based on anticipated production levels.

As the coal is mined, the overlying soil and rocks will be removed and the affected acreage will be lost to grazing and rangeland recreation for a period of five or six years.

The impacts arising from the short-term use of the environment will be minimized to the greatest extent practicable consistent with modern mining and reclamation practices. Grading of spoils will reduce ridges to a rolling topography aesthetically consistent with surrounding undisturbed areas. Replacement of soil material and establishment of vegetative cover will return mined land to grazing as soon as possible following extraction of the coal.

Mining will temporarily disrupt the flow of surface water. Ground water levels may be lowered locally because of the removal of parts of aquifers

in unconsolidated material, sandstone, and coalbeds. Rainwater and water flowing into the mined area will probably be retained by infiltration into the spoils, creating perched water tables.

The preceding indicates that the short-term use of parts of the leasehold for mining will be accompanied and followed by a period of reclamation and revegetation. Although the land's appearance will be permanently changed, its attractiveness should not be adversely affected. Other potential long-term land uses may be impaired by introduction of heavy industry, housing developments, and development of other resources. In addition, coal used for power generation will not be available for other uses or for future use.

At maximum production, 231 acres will be disturbed by mining each year with an equal number of acres undergoing grading and planting. At any one time the total area disturbed will be about 500 to 600 acres. Since final reclamation of a particular area is estimated to lag about five years behind mining, wildlife and livestock will be displaced for at least that period of time.

In summary, the land will be used for mining coal rather than for grazing and wildlife habitat for a period of five to ten years at which time the land should be restored to its former or other designated uses.

Disturbed land, presence of heavy equipment, other mine-related facilities, and associated noise, dust, and solid waste will be only of short duration. After mining, reclamation, and revegetation is completed, the principal long-term changes will be local modification of the topography and of surface drainage systems, and loss or reduction of productive capacity.

It is estimated that the total productive capacity of the land will be reduced 50 percent over present levels even if revegetation is successful. Reclamation techniques in this semiarid climate have to be tested before any final predictions can be made as to success ratios.

Wildlife habitat for those animals which depend on a sagebrush type will be destroyed for a period of 20 to 50 years. Figure 7 in Chapter V of Part I shows the time span from point of disturbance which is required for replacement of adequate habitat for various animals groups.

Mining of this area will involve a long-term loss in productivity. Under climatic conditions which prevail for this area, the area may never regain its present productive capacity.

CHAPTER VIII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The major commitment of resources is the mining and consumption of 300 million tons of coal over the 22-year life of the mine. This loss represents about 2.4 percent of the economically strippable reserves of the Eastern Powder River Coal Basin.

Use of an indeterminable amount of sand and gravel and clinker for aggregate in the construction of mine facilities, railroad loop and access road will occur. Clinker, sand, and gravel deposits mined with the overburden and moved with other spoil will be irretrievably lost.

The only ground water aquifers that will be irreversibly committed are those aquifers that will be physically removed during mining. Adjacent parts of these aquifers will be affected during mining operations but water levels are expected to return to normal after mine dewatering stops. The chemical quality of water in the aquifers will not be changed.

Extraction of coal and reclamation of disturbed areas will require the use of electrical power, lubricants, liquid fuels including diesel fuel and gasoline, ammonium nitrate explosives, and structural materials for construction and repair of surface buildings. Chemicals and materials used in mining and reclamation would also be lost for other uses.

Large amounts of diesel fuel will be used in transporting the coal via rail line. By 1985 the consumption of fuel just within the study area will amount to 7.2 million gallons per year. This fuel will be consumed and unavailable for future use.

Loss of life will occur both in the mining operations and associated with increased vehicular and train traffic. Based on fatal accident rates experienced in the strip mining industry during 1972, one employee will suffer a fatal accident for every 14.3 million tons of coal produced. Disabling injuries will occur at the rate of 9.24 per million man hours worked. Therefore, during the life of the mine an estimated 21 people will lose their lives. This will be an irretrievable commitment of human resources.

Any destruction of archeoloigcal or paleontological values will be an irreversible commitment of resources.

It is doubtful that total reestablishment of the complex native plant community is possible on disturbed areas of the mined area. Strip mining and associated activities will eliminate a portion of this life-support community which is the major irreversible impact to wildlife in the area.

Wildlife resources that may be irretrievably lost include individual animals and habitats that are destroyed. Animals and plants that would have reproduced in the affected habitats during the life of the mining operation may also be irretrievably lost. Most wildlife losses may be reversible if the species and habitat are not impacted to the point that their ability to reproduce is seriously impaired.

It is doubtful if full production can ever be restored to areas severely disrupted by strip mining. The assumption has been made that if even upon revegetation, the productivity capacity will be reduced 50 percent of previous capacity. Until further research is conducted, this has to be considered an irreversible commitment of resources.

The annual forage production which the area could have produced will be lost during the time that mining takes place. Production could be lost on 300 to 500 acres annually. This increment of production lost is an irreversible commitment of the livestock forage.

CHAPTER I

DESCRIPTION OF THE PROPOSED ACTION

Background and History

The Wyodak mine is located 5 miles east of Gillette, Wyoming on U.S. Highway 14-16 (Figure 1). The highway and the main line of the Burlington Northern railroad divide the mine into a North Pit and a South Pit. It is operated by the Wyodak Resources Development Corporation, a subsidiary of the Black Hills Power and Light Company.

The Wyodak Coal and Manufacturing Company opened a mine in 1925 on privately owned coal in what is presently called the North Pit at the Wyodak mine. By 1927 it was producing 300 tons daily. In 1959, the company leased 240 acres of federal coal land south of the highway (W-073289) (Figure 2) and moved the mining operation to this South Pit in the same year. The company was awarded an 80-acre federal lease north of the highway in 1961 (W-0111833). The North Pit was placed on a standby basis in case the South Pit should ever be flooded by Donkey Creek. In 1965 the company was awarded a federal lease of 2,200 acres (W-0313666) adjacent to the North Pit as a reserve for their mining operation. The acreage was reduced in 1972 to 1,560 acres on this lease. The company paid only one dollar per acre bonus for the first and second lease but was required to bid $25.55 per acre for the third lease.

The lease (W-073289) is a continuing lease subject to reasonable readjustment of terms on a 20-year basis. The first 20-year period will end on May 1, 1979. The terms for the first 20 years provide for a royalty of 10 cents a ton for coal mined for the first 10 years of the lease and 12½ cents a ton

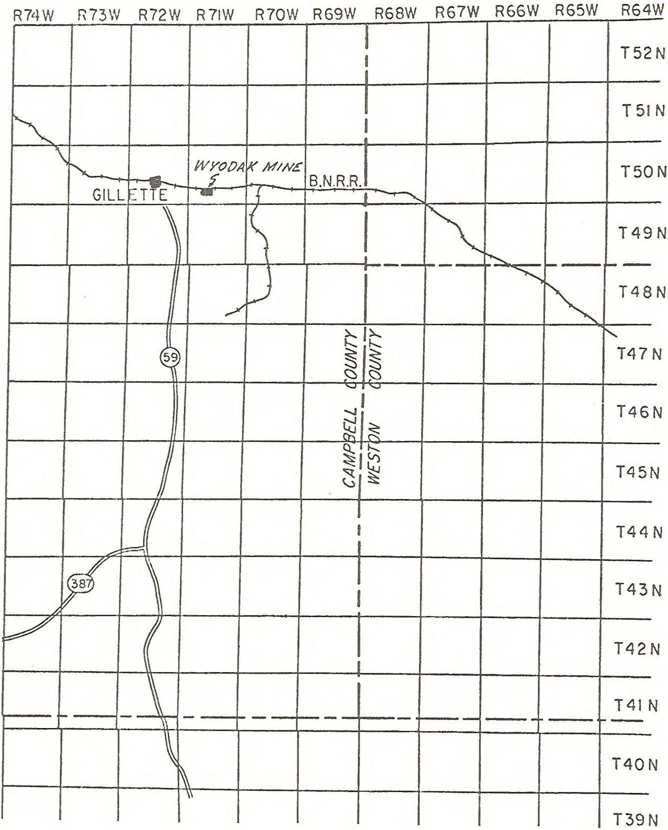


Figure 1

Location of the Wyodak Coal Property of the Wyodak Resource Development Corporation, Campbell County, Wyoming.

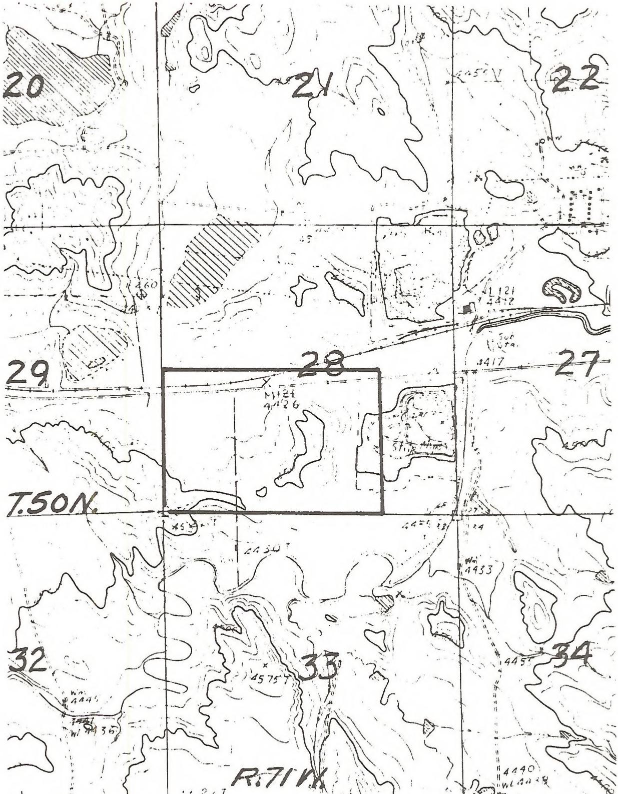


Figure 2

Wyocak Resources Development Corporation Federal Coal Lease W-073289
Showing Location of Existing Pits.

during the next five years, and 15 cents a ton during the remainder of the first 20-year period of the lease. The annual rental per acre or fraction thereof, is set at $0.25 per year for the first year; $0.50 for the second, third, fourth, and fifth years; and one dollar per acre for the sixth and each succeeding year during the continuance of the lease, such rental for any year to be credited against the first royalties as they accrue under the lease during the year for which the rental was paid. A minimum annual production requirement is based on an annual royalty value of one dollar per acre or fraction thereof starting the sixth year of the lease.

The company submitted a mining plan on November 16, 1973, for the South Pit of their Wyodak mine (Figure 3). It outlines their proposed activities through 1988 when mining will be completed in the South Pit and will move to the North Pit. The plan outlines details for mining 160 acres of coal land leased from Homestake Mining Company, 40 acres of coal land owned by Wyodak, and 240 acres of coal land under federal lease W-073289. The plan is available for public inspection in the office of the area mining supervisor (USGS), Billings, Montana and is presently being reviewed for adequacy by the U.S. Geological Survey and the Bureau of Land Management.

Surface and coal ownership of the mining area is given below.

	Surface	Coal
United States	0	200
Wyodak	240	40
Other Private	160	160
Total	400	400

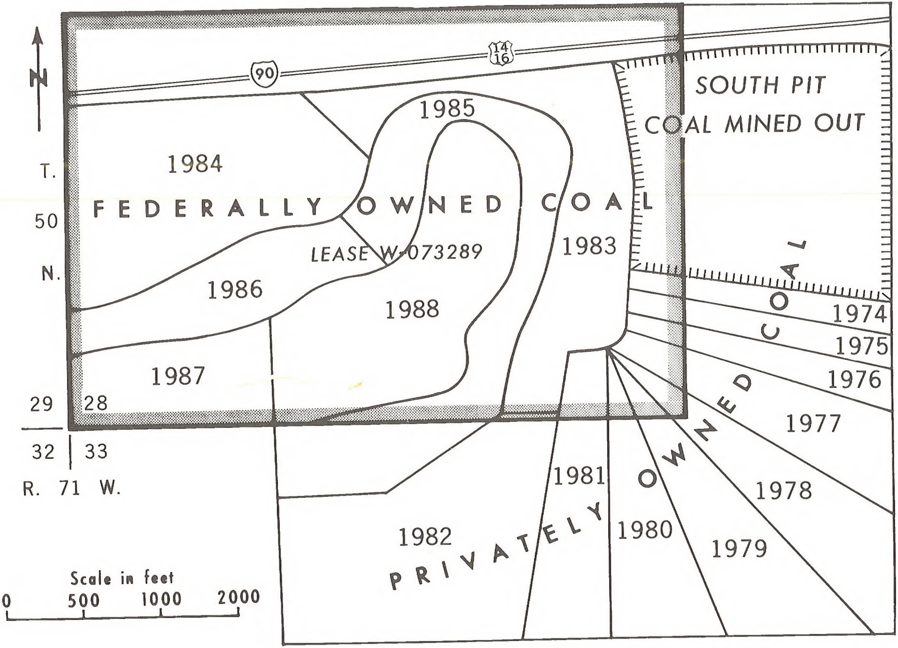


Figure 3

Wyodak Resources Development Corporation Areas to be Mined Per Year

The lease presently contains no special stipulations for reclamation but under section 5 of the lease, which covers protection of the surface, reclamation of the land is required. When the terms of the lease are readjusted in 1979, special stipulations covering detailed reclamation requirements will be included in the new terms. Under the present terms of the lease, no mining plan will be approved which does not provide for adequate reclamation. A copy of the lease is contained in Appendix D.

Mining is presently in the S½SE¼ of section 28 which is called the South Pit. The coal is being loaded from a strip about 1,700 feet wide. Approximately 1,300 feet of this strip is on coal land owned by Homestake and 400 feet is on land included in the federal lease.

The Wyodak mine is presently mining 700,000 tons of coal per year for power plants of the Black Hills Power and Light Company in Wyoming and South Dakota. About 400 tons of coal per day is burned in a 20-megawatt air-cooled plant at the mine. Construction will start in the spring of 1974 on a mine mouth plant which will be the world's largest air-cooled power plant (330 megawatts), and will be located adjacent to the existing power plant. The proposed unit will consist of a coal-fired steam generator and a direct turbine-drive electric generator.

All buildings will be enclosed while all conveyors will be enclosed in galleries and the storage bin will be roofed. The plant facilities will cover approximately 10 acres. The plant is scheduled to start generating power in 1977 and will burn 1½ million tons of coal per year.

Tentative plans call for completion of another mine mouth power plant in 1982 at this same location. It is proposed that this plant will have a 450-megawatt generating capacity although the final size could vary from 380 to 660 megawatts.

Purpose of proposed project

Development of the Wyodak mining operation and related power plant facilities is planned to meet the increased electrical loads of the area. The coal production required to supply the existing and proposed power plants are as follows:

Year	Million Tons
1974 - 1976	700,000 per year
1977 - 1981	2,500,000 per year
1982 - 1988	5,000,000 per year

A mining and reclamation plan for this proposed mine as well as power plant and surface facility plans were submitted on November 16, 1973.

Site location

The Wyodak Mine operated by Wyodak Resources Development Corporation is located in T50N, R71W, in Campbell County, Wyoming (Figure 2). For a more detailed description see Appendix D.

Gillette, the county seat of Campbell County, is five miles west of the minesite. A main line of the Burlington Northern railroad serves the town of Gillette and runs east-west passing near the mine site. Interstate highway 90 is partially completed across northeastern Wyoming with U.S. Highway 14-16 connecting the completed sections. This interstate route is the main east-west highway serving northeastern Wyoming. Interstate highway 25 is partially completed with U.S. Highway 87 connecting the completed sections. This interstate route is the main north-south highway serving eastern Wyoming.

Stages of Implementation

Proposed mining procedures

The following description of mining and reclamation activities is taken, with modification, from the mining and reclamation plan submitted by Wyodak Resources Development Corporation.

The present mining operation will continue southward through 1977 and then will swing westward until the mining face is north-south. By 1982 all of the coal land leased from Homestake Mining Company will be mined ($E\frac{1}{2}SE\frac{1}{4}$ of sec. 28 and $N\frac{1}{2}NE\frac{1}{4}$ of sec. 33). Mining in 1982 will be on the private coal owned by Wyodak. From 1983 through 1988 the mining will be mostly from the federal lease.

Soil material removal

The first step in the mining operation is to remove the uppermost material defined as soil material and spread it over spoil that has been reshaped. In this case the soil material will be spread over land that will be above the water level of a potential lake to be created by mining.

According to a study conducted in 1969 by the U.S. Department of agriculture, Soil Conservation Service, the topsoil depth ranges from two inches on knolls or hills to several feet in the valleys of the coal lease. Soil material would include a thicker zone than that classified as topsoil. Soil material could be defined as oxidized and weathered material in the root zone that is capable of supporting plant growth under existing conditions. Approval of the mining plan will probably be based on the condition that the company recover at least the top 12 inches of overburden as soil material. This material will be recovered and spread with wheel scrapers.

Overburden removal

The overburden has been removed with scrapers in the South Pit and has averaged about 30 feet in thickness. In 1982 stripping operations will be moved from along Donkey Creek to the W½SE¼ of sec. 28 where the overburden is 50 to 60 feet thick. At that time the company plans to use a shovel and trucks to remove the overburden.

Company officials believe a dragline will be needed when the overburden averages more than 70 feet in thickness. In 1986 or 1987 they plan to start using a dragline with about a 40-yard bucket. The overburden mined during this period will average over 100 feet thick and attain a maximum thickness of 145 feet.

Enough coal has been stripped with scrapers to last the loading operation through 1976. For reclamation purposes, scrapers are ideal to remove overburden. The scraper is loaded with overburden from one zone and the contents can be placed on spoil piles so that undesirable material is buried. The spoil piles can be shaped as the material is unloaded from the scrapers.

Coal removal

The coalbed presently being mined in the South Pit is about 70 feet thick with a 10-to 16-inch parting 34 feet from the base of the coal. The bed is presently mined in two benches. The top bench is generally maintained from 200 to 400 feet ahead of the lower bench. This practice has varied according to the market demand for the quality of coal found in each coalbed.

Coal in each bench is prepared for blasting by drilling 5-inch holes on 25-foot centers. Each hole is loaded with 125 pounds of ammonium nitrate-fuel oil prills.

All blasting is done in accordance with applicable safety regulations. Broken coal is loaded with a 14-yard front-end loader into trucks. The company is presently using two 70-ton capacity trucks and five trucks having a capacity of 30 tons. The trucks dump into a hopper at the primary crusher in the North Pit. The coal is carried to the preparation plant by a 36-inch conveyor belt 1,340 feet long.

Part of the coal goes to a preparation plant where it is sized and oiled for the domestic market. Some of this coal is shipped according to customer specifications in railroad cars and some is sold and trucked to local markets.

When production approaches 2.5 million tons of coal per year, the company will need an additional front-end loader having a 14- to 20-yard capacity. They will also purchase additional drop-bottom trucks, each having a capacity of 100 to 120 tons.

Coal will be delivered to the new power plant over a 54"-wide belt, which will extend from the South Pit to the new plant, or it will be stored in a 14,500-ton silo for use at a later time. The belt line will be about 3,300 feet long.

Reclamation

Pursuant to Interior Department policy, all reclamation activity on federal coal lands will conform to the mining plan approved for the federal lease (W-073289), all applicable federal operating regulations, and to requirements of the Wyoming Environmental Quality Act of 1973. Before any mining is started in Wyoming, the operator must obtain a permit from the State which entitles the operator to mine in conformance with an approved reclamation plan. The state may agree to a lake in the reclaimed area but will probably insist that any land

not included in the lake be returned to low undulating topography suitable for grazing and that native or better quality grass be planted.

Usual reclamation procedures will not be practical in the thick coal bed and thin overburden found at the Wyodak mine. If the overburden were returned uniformly to the pit after mining and the land returned to its original surface contours, a depression in the earth of 60 to 80 feet would exist over all of the mine area. Where the overburden is less than the thickness of the coal, the surface level would be lower than the water table and unwanted lakes having swamplike edges would form. The practical approach is to plan in advance for a lake and use the available spoil to reclaim land exclusive of the lake area.

Spoil reclamation

The company has reclaimed five acres of land in the northwest corner of the South Pit by filling it with spoils to the level of the original surface. This reclaimed land has been planted with grass. They have also reclaimed a four-acre tract near the northeast corner of the pit by grading the spoils on a 5:1 (11°) slope from the top of the coalbed for a distance of 450 feet toward the center of the pit. This area is being used for experimental purposes. Part of it has been covered with topsoil and seeded, part of it has been covered with topsoil and was not seeded to experiment with natural reseeding, and part of the tract was seeded on spoil without topsoil.

The coalbed in abandoned areas must be covered to prevent spontaneous combustion of the coal. This is especially true in the Gillette area where the coal ignites easily. With the small amount of overburden available during the first nine years of the operation, most of the available spoil material will be needed to cover this exposed coal.

The proposed reclamation plan calls for using available overburden to form a bench around the edge of the pit level with the top of the coal. The eastern and southern edge of the pit will be on privately owned coal. It is proposed that the bench on the eastern edge will be 24 feet lower than the original surface and will be level for 280 feet before it is sloped off on a 35° angle. If the reclamation is successful on the experimental tract, it is likely that the reclamation plan will be changed from the 35° slope to the 11° slope used in the experimental area.

The highwall along the western edge of the pit will be on federal-owned coal through 1982. During 1983 the coal along this highwall will be mined, therefore, any reclamation done here will be temporary and only to prevent the coal from igniting until it is mined. The reclamation plan calls for a bench 50 feet wide to be formed level with the coal along this temporary highwall and the edge of this bench will slope toward the center of the pit on a 35° angle.

During 1983, the first highwall on federal coal will be permanently abandoned. At that time the overburden will be 50 to 60 feet thick and enough spoil will be available to start reclaiming part of the land into a rolling topography blended into the highwall. It will still be necessary to include part of the land mined at this time in the proposed lake.

Drainage control

Donkey Creek originally flowed through all five of the 40-acre tracts of private coal included in the mining plan. This perennial stream has been diverted around the present mine and further diversion will be needed to mine the proposed area. Company officials recognize that an unusually large flood might overflow banks of diversion ditch and flood the active pit area. Employees in the pit would probably have ample warning to avoid danger but the damage could

be very expensive to clean up. A flood would do no permanent damage to the mine.

Studies by geologists and consulting engineers for Black Hills Power and Light report that the potential for drawing any large amount of water from shallow wells (400 to 600 feet deep) is extremely poor. This low potential would indicate that the coal seam does not contain large volumes of underground water. Most of the water entering the pit from the coalbed probably seeps in from Donkey Creek. This water is pumped back into Donkey Creek. Water analyses reported by the company in the area are as follows:

	Ditto Lake	Donkey Creek	Wyodak Pit	Wells (by formation) Wasatch	Fort Union	Fox Hills
Silica, ppm as SiO_2	30	31	8	-	-	20
Total Dissolved Solids, ppm	1,490	3,000	1,450	2,734	330	1,150
Total Alkalinity, ppm as $CaCO_3$	250	560	240	-	280	-
Total Hardness ppm as $CaCO_3$	947	1,210	780	1,978	48	16
pH	7.3	7.5	7.5	6.8	7.1	8.2

Seeding

The center of the pit will not be seeded because it will be a working area during the mining operations and will be flooded as the pit fills with water. The company proposes to cover the spoils which will be above the water level with available topsoil and to seed them with crested wheat grass.

Surface facilities

Wyodak Power Plant

Two companies are building a 330 megawatt (MW), coal fired power plant at Wyodak, five miles east of Gillette, Wyoming. Pacific Power and Light Co.

and Black Hills Power and Light Co. will locate their new facility adjacent to the 30-MW Neil Simpson plant operated by Black Hills Power. The 330-MW plant is scheduled for operation in 1977. It will use air cooling technology, proven successful at the Simpson generating station. Air cooling is necessary because sufficient water is not available. The companies also have tentative plans for a third plant at this site expected to produce 450 MW of electricity in 1982.

According to documents filed with the Wyoming Public Service Commission, Black Hills Power will require 169 MW of power by December 1977 with resources of 87 MW without the Wyodak plant described here. Pacific Power projects a requirement of 165 MW to service Wyoming loads by the winter of 1977-1978. Both companies will also need reserve capacity to meet future growth. These needs will be met by the plant under construction.

About ten acres of land are required for each power plant with some 30 acres disturbed during construction. Existing highway access from U.S. Highway 14-16 will be used to reach the site and less than one-half mile of temporary railroad spur will be needed to construct both plants.

Coal for the power plants will come from expanding production from the Wyodak mine now operated by a subsidiary of Black Hills Power. Coal will be delivered to the new plant over a 54-inch conveyor belt extending from a truck hopper and crusher in the South Pit to the new plant. Coal can be diverted to a 14,500-tons silo for storage from a transfer plant on the belt. It can then be returned to this transfer point for use in the plant. When in full production the 330-MW plant will consume 1.5 million tons of coal per year; the second plant about 2 million tons annually. The coal averages 0.5 percent sulfur content, according to company analysis.

By selecting the air cooling process, water requirements for the 330-MW plant are quite low. About 200 to 300 gallons per minute will be obtained from

a combination of sources, including wells in the vicinity, Ditto Lake, and effluent from the proposed Gillette sewage plant. Domestic water will be obtained from wells drilled to the Fort Union or Fox Hills formations.

The general processes involved in generating electricity from fossil fuel have been described previously. The technology at the Wyodak plant includes:

1. A coal fired steam generator designed to produce 2,600,000 lbs. of steam per hour at 1,000°F superheat and 1,000°F reheat.
2. A turbine rated at 330 MW.
3. An air cooled condenser to convert steam to water and to release the unrecovered heat produced to the atmosphere.

Bottom ash and all other solid products from the power plant will be interlayed with overburden and returned to mined-out areas. All sewage wastes will be treated at the site to meet state and federal water quality standards.

Air pollution control equipment, including electrostatic precipitators with provisions for wet scrubbers for sulfur removal, if necessary, have been designed and tested to comply fully with Wyoming and federal air quality standards. Fly ash collected in the pollution control system will be buried in the mined-out areas. Airborne emissions from a 400-foot stack include: 90 lbs. per hour total particulates, 320 lbs. per hour of sulfur dioxide and 288 lbs. per hour of nitrogen dioxide for the 330-MW plant. Both the Wyoming Public Service Commission and the Environmental Protection Agency have reviewed plans for the plant and have issued necessary construction permits.

To deliver the power produced, Pacific Power will build a 230 kv transmission line west to Buffalo, Wyoming; Black Hills will build a corresponding line from the plant site to Spearfish, South Dakota. Another 230 kv line from Wyodak south to Glenrock may also be tied into the distribution system.

Roads

All haul roads will be constructed on the bottom of the pit. They will be used to move coal from the loading shovel to the truck hopper located in the bottom of the pit. The roads into the pit will be used only for access to the mining operation.

Railroad spur

A railroad loop and rail car loading facilities will not be needed at this operation. Although production will be substantially increased, the annual amount of coal shipped by rail will not be changed. A 700-foot railroad siding and 1100-foot spur track will be constructed and used in the operation of the power plant.

Power

Electric power for the mine shops, electric shovels, crushing station, and loading facilities will be supplied from the existing power plant located adjacent to the mine.

Office and shop

Office and shop facilities will be required at the mine site but specifications as to size and type of structures have not been finalized at present.

Mining, loading, and reclamation equipment

The following equipment will be used during the mining, coal loading and reclamation operations:

No. of Units	Equipment	Capacity	Manufacturer's Trade Name
1	Front-end Loader	14 yards	Hough "700"
5	Trucks	30-ton	Euclid
2	Trucks	70-ton	Caterpillar
2	Scrapers		Caterpillar "621"
1	Coal Drill	5-inch hole	Salem
2	Tractors		Caterpillar "D-8"
1	Tractor		Caterpillar "D-7"

The following additional equipment will be needed before mining is completed in the area outlined in the plan: Front-end loader (20-yard bucket), several additional trucks (100-ton), an overburden drill and an overburden shovel (16-yard). Also a shovel and/or dragline may be needed when the overburden increases to a depth of 70 feet or more.

Mining sequence

The company is mining a 1,700-foot working face in the South Pit. Mining extends across fee-owned SE¼SE¼ of sec. 28 and 400 feet into the SW¼SE¼ of sec. 28 which is included in the federal lease. This working face will be advanced about 175 feet each year from 1974 through 1976. Starting in 1977 the east end of the mining face will be advanced much faster than the west end in order to rotate the mining face in a fan-like turn. When the turn is completed by the end of 1980 the mining face will be in a north-south direction.

The fee-owned coal in the NE¼NE¼ of sec. 33 will be completely mined during this period and the working face will extend 450 feet into the federal lease.

The operation will mine about 40 acres of coal land each year to produce the projected five million tons annually after 1981. During 1982 all of the remaining fee coal will be mined except for 10 acres to be mined in 1985.

The thickest overburden forms a ridge which lies diagonally across the federal lease. The coal underlying this ridge will be mined during 1987 and 1988, the last two years covered by the plan.

Transportation and marketing

Except for a few thousand tons sold on the commercial market, all of the coal produced at the Wyodak mine is burned at four power plants owned by the company in Wyoming and South Dakota.

The mine is currently producing about 700,000 tons of coal per year. About 450,000 tons of the production is shipped by rail to power plants in Osage, Wyoming; Rapid City, South Dakota; and Lead, South Dakota. The remainder of the production is used at the 20-megawatt air-cooled plant at the mine or sold on the commercial market. All of the projected additional tonnage to be produced at the mine will be burned in two new units of the power plant to be constructed near the mine site. The rail shipments during the period of the mine plan should remain constant at about 450,000 tons per year.

CHAPTER II

DESCRIPTION OF THE EXISTING ENVIRONMENT

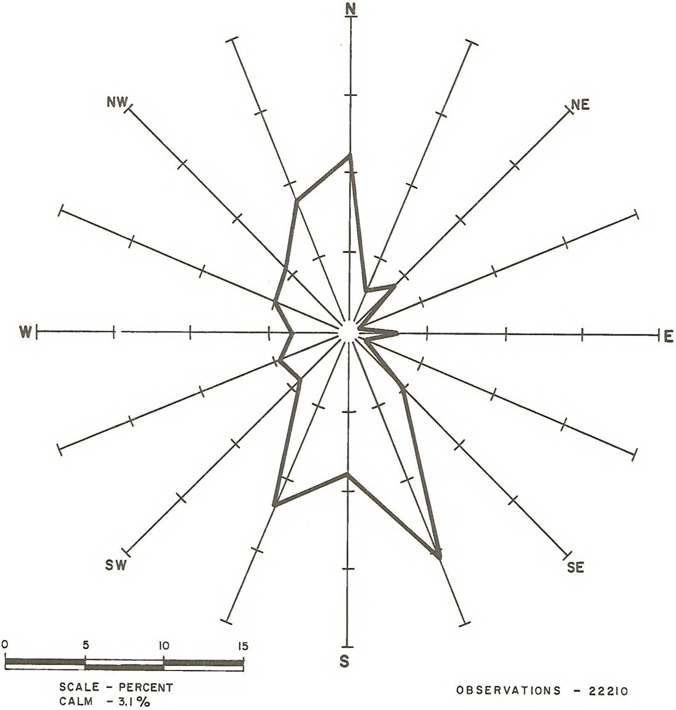
Air Quality

The Wyodak coal property is located in the Wyoming Intrastate Air Quality Control Region (Figure 2, Chapter IV, Part I).

Wind direction, inversion occurrences, monitoring information, and present ambient air quality are described for the region in Part I, Chapter IV.

Data compiled on wind direction from observations taken at Moorcroft, Wyoming, which is 20 miles to the east of Wyodak, is shown in Figure 1. This station is considered to be representative of the Wyodak area, and its wind distribution rose shows surface winds are predominantly north and south on an annual basis with a dominant south-southeasterly flow for about 15 percent of the time. Average annual wind speed at Moorcroft is 10 miles per hour.

Present ambient air quality at the coal mine is influenced by pollutants from the City of Gillette (5 miles to the west), by emissions and dust from mining, by hauling and processing of coal at Wyodak's mine, and by emissions from the Neil Simpson power station (coal fired). Data collected on suspended particulate matter at Gillette from June 1972 to June 1973 indicated a range of 20 to 190 micrograms per cubic meter (ug/m^3) (data from National Air Surveillance Network, Environmental Protection Agency). Emission rate estimates for the Neil Simpson station's four stacks are given in Table 7, Chapter IV of Part I.



Source: USDC, NOAA Environmental Data Service, Monthly and Annual Wind Distribution by Pasquill Stability Classes, Moorcroft, Wyoming, 1973

FIGURE 1
WIND DISTRIBUTION ROSE
PERCENT OF TOTAL OBSERVATIONS
MOORCROFT, WYOMING
PERIOD - ANNUAL 1/50 - 7/52

Topography

The Wyodak mine is in the unglaciated part of the Northern Great Plains Province in Campbell County, Wyoming. The lease area is a small part of a broad plateau extending from Gillette to the Cheyenne River and characterized by hummocky clinker, irregular escarpment, local narrow ridges, knobs, and narrow floodplains in wide, shallow valleys.

The landscape is dominated by a bench or step that is eroded along the valley sides on a massive bed of resistant sandstone over 100 feet thick. Fused or baked clay and sand from the burnt coal form resistant clinker deposits that locally protect the massive sandstone from weathering. In some places east of the burnline the sandstone is eroded into isolated buttes and cones, colorful cliffs and badland; the aggregate east-facing timbered escarpment is known as the Rochelle Hills.

The site area is characterized by rolling grass-covered prairie, whereas east of the site, the land surface is broken and dissected by steep-walled narrow stream channels. Pine trees cover the rough, rocky sandstone cliffs to the east. Here the stream courses are steep-sided gulches littered with boulders of red clinker and buff ferruginous sandstone. The narrow valleys widen eastward. The mine area is locally drained by the eastward-flowing Donkey Creek and its tributary streams.

Altitudes in the vicinity of the lease range from 4,412 feet at the power plant to 4,300 feet in the bottom of the north and south mine pits and about 4,516 feet on a nearby hillside. The maximum relief is nearly 215 feet.

Soils

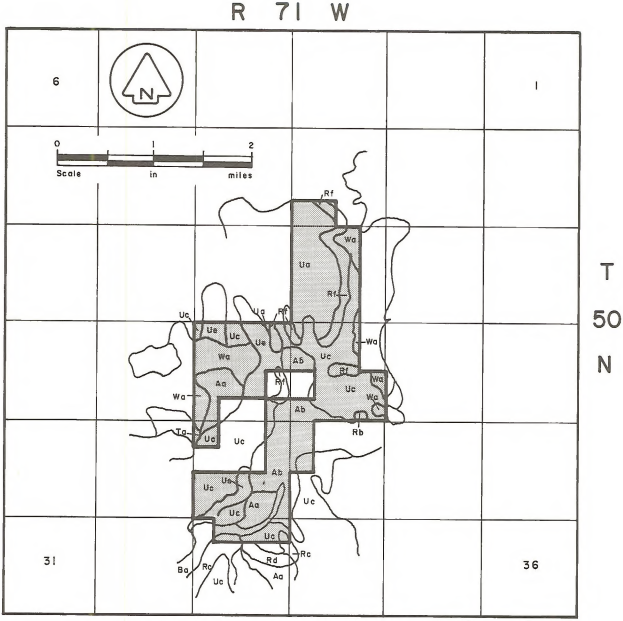
The Wyodak Coal property includes approximately 2,080 acres. The coal mining plan for the south pit mine outlines their proposed activities through 1988 when mining will be completed. The south pit includes 440 acres of which 240 acres is under federal lease. The north area contains 1,640 acres of federal lease.

The best available soils data for the mine area is provided by the Soil Conservation Service, Campbell County Reconnaissance Soil Survey. The field work was completed in 1939 and published in 1955. Recent and up-to-date soils data for Campbell County was utilized when applicable and available.

Six major soil types occur within the coal lease as shown in Figure 2. Generally, the soils have developed from shale material weathered in place and are shallow over bedrock. Tables 10 through 28, Appendix C, give a description of each soil series and lists their physical, chemical, and management interpretations. Table 1 gives a description of their characteristics, limitations, and suitabilities. A brief summary and acreages for the major soil types follow:

The Arvada soil types occupy approximately 460 acres. These soils occur on sloping terraces and alluvial fans. They are moderately deep (20-36 inches), strongly alkaline, and very high in exchangeable sodium. Productivity is very low and present erosion is high. These soils are unsuitable for agricultural use, road fill, building construction, and other uses.

The Ulm soil types occupy nearly 1,070 acres. These soils occur on the rolling to steeply sloping uplands that are strongly dissected by gullies. Depth to bedrock ranges from 10 to 20 inches. Productivity is medium, yielding approximately 500 to 1,500 pounds per acre of total dry vegetative matter. Present erosion condition is high.



SYMBOL	LEGEND	SERIES
Aa–Ab		Arvoda cloy – cloy loam
Bo		Bonkord fine sand loom
Rb–Rc–Rd		Renohill clay loom
Rf–Rh		Rough broken lond
Ta		Terry laamy sand
Uo		Ulm clay laam
Uc–Ud–Ue		Ulm loom
Wa		Wiboux – Seoring Complex

Source: USDA, Soil Conservation Service, Soil Survey, Campbell County, Wyoming July 1955, Soil Map, Sheet No. 3

Fig. 2
Generl Soils Map (Wyodak Coal Property)

Table 1

Wyodak
Soil Interpretation Summary *

Soil Unit		Erosion Hazard Potential **		Revegetation Potential	Suitability for Sprinkler Irrigation	Suitability for Final Cover for Mined Land		Suitability for Transportation Routes	Suitability for Roadfill	Suitability for Sanitary Facilities: Septic-Tank Absorption Fielda	Suitability for Sanitary Facilities: Sewage Lagoons	Suitability for Sanitary Facilities: Sanitary Landfills (Trench)	Suitability for Small Commercial Bldgs.
Symbol	%Slope	Water	Wind			In. Available	Suitability						
Aa	0-5	M	M	L	L	0	L	L	L	L	L	L	L
Ab	5-10	H	M	L	L	0	L	L	L	L	M	L	L
Rb	0-5	M	M	M	L	6	M	L	L	L	L	L	L
	5-10	H	M	M	L	6	M	L	L	L	L	L	L
Rf	20-30	H	L	L	L	0	L	L	M	L	L	L	L
	30-40	H	L	L	L	0	L	L	L	L	L	L	L
	40-50	H	L	L	L	0	L	L	L	L	L	L	L
Rh	20-30	H	L	L	L	0	L	L	M	L	L	L	L
	30-40	H	L	L	L	0	L	L	L	L	L	L	L
	40-50	H	L	L	L	0	L	L	L	L	L	L	L
Ua	0-5	M	M	L	L	6	M	L	L	L	L	L	M
Ub	5-10	H	M	L	L	6	M	L	L	L	L	L	M
Uc	0-5	M	M	M	M	16	M	M	M	L	L	L	M
	5-10	H	M	M	M	16	M	M	M	L	L	L	M
Ue	10-20	H	L	L	L	10	M	L	M	L	L	L	M
	20-30	H	L	L	L	10	M	L	M	L	L	L	L
	30-40	H	L	L	L	10	M	L	L	L	L	L	L
Wa	5-10	H	L	L	L	8	L	M	H	L	L	L	H
	10-20	H	L	L	L	8	L	L	H	L	L	L	M
	20-30	H	L	L	L	8	L	L	M	L	L	L	L

* - 3 Classes - L - Low, M - Moderate, H - High.
** - Estimated on-aite erosion, bare aoil conditiona, L - 3.T./ac, M-3-8 T./ac., H - 8T./ac.
Source of interpretations: 1. Descriptiona from Campbell County. 2. Soil Conservation Service soil profile descriptions. 3. S.C.S. Form 5, Interpretation sheet. 4. Region 2, F.S. Guidelines for Soil Interpretations. 5. S.C.S. Guide for Interpreting Eng. Uses of soils.

The Wibaux-Searing complex occupies nearly 200 acres on rolling to hilly topography. They are characterized by numerous outcrops of unweathered scoria. These soils are very shallow (10") and gravelly to very gravelly loam. Productivity is low, yielding approximately 450-1,200 pounds per acre total dry matter. The Wibaux soils are unsuitable for agriculture.

A miscellaneous land type comprised of rough broken lands and scoria land makes up nearly 320 acres. The rough broken lands consist of steep, eroded, strongly dissected areas along escarpments and steep-walled drainage channels. Fragments and blocks of red shale and clinker are scattered on the surface. These soils are highly eroded, unsuitable for agricultural use, and productivity is low for native vegetation.

The Terry soil type occupies approximately 20 acres on moderately sloping to steep sidehill slopes. Depth to bedrock is 20 to 30 inches. Productivity for native vegetation is medium, yielding about 1,000-1,500 pounds per acre total dry matter. Present erosion is high due to steep slopes and fine sandy loam textures that are susceptible to wind and water erosion if protective cover is removed.

The Renohill soil types occupy about 10 acres on gently sloping to rolling uplands underlain by weathered shale at depths of 20-40 inches. Soil reaction is moderately alkaline at 6 to 20 inches. Internal drainage is slow due to the clay subsoil. Productivity for native vegetation is medium, ranging from 750-1,800 pounds per acre dry weight. Agricultural use is limited due to shallow depth to bedrock and alkalinity. Present erosion condition is high and susceptibility to erosion is very high if vegetation or protective cover is removed.

Summarily, the soils occurring within the Wyodak lease area are moderately to highly susceptible to wind and water erosion if present vegetation

is removed and topsoil disturbed. The revegetation capabilities are fair as most of those soil types are moderately productive. These soils contain a shale subsoil that require special management practices to avoid compaction, runoff, and revegetation problems. Approximately half of the acreage (1,100 acres) situated within the mining area are moderately productive agricultural soils containing about 10 inches of suitable topsoil. These soils are primarily made up of the Ulm series. The remaining 980 acres are not suitable for agricultural use and low in productivity.

Detailed soil inventories and studies need to be conducted to quantify and measure actual soil losses, sediment yield, production capability, soil moisture loss, bulk density, infiltration, permeability, chemical elements, and compactibility for each soil series.

Reference should be made to Glossary for an explanation of terms.

Mineral Resources

Stratigraphic and structural relations

Wyodak Resources Development Corporation's federal coal leases in T50N, R71W are on the gently dipping eastern flank of the Powder River Basin (Figure 10, Chapter IV, Part I). This broad regional downwarp contains nearly flat-lying rocks of Tertiary age in the center surrounded by Cretaceous and progressively older rocks that are upturned on the flanks of the bordering Precambrian-cored mountains--the Black Hills to the east, the Bighorns to the west, and the Laramie Range to the south (Figure 11, Chapter IV, Part I). Northward, the basin indistinctly blends into the Great Plains. The leases are in the Powder River coal field that was mapped by Stone and Lupton (U.S. Geological Survey 1908) and in the Minturn district as mapped by Thom (U.S. Geological Survey 1927). The site was also included in a regional geologic study by Robinson and others (U.S. Geological Survey 1964). These reports and the information submitted by the Wyodak Resources Development Corporation in their proposed mine and reclamation plans for the leases form the basis for the following summary of geology and coal resources.

Surface rocks on the lease areas are the lower part of the Wasatch Formation of Tertiary (Eocene) age and alluvium of Quaternary or Recent age. The Wyodak coalbed that is being mined on the leases is, for all practical purposes, the top unit of the Fort Union Formation which underlies the Wasatch. The coalbed does not actually crop out in the lease areas. The Fort Union Formation is underlain in turn by the Upper Cretaceous Lance Formation and Fox Hills Sandstone. The base of the Fox Hills is at a depth of about 3,000 feet below the surface in the lease areas; the underlying Pierre Shale extends to a depth of about 7,500 feet; succeedingly older sedimentary formations representing Mesozoic and Paleozoic ages extend to a depth of about

14,000 feet to the top of the Precambrian igneous and metamorphic rock complex.

The Fort Union Formation below the Wyodak coalbed is partially exposed about one-fourth mile east of the lease area. The rocks are light- to drab-gray clay shale, gray siltstone, yellowish-gray, fine-grained sandstone, and thin carbonaceous shale and coalbeds.

The Wasatch Formation, which along with alluvium forms the overburden being stripped at the Wyodak mine, ranges from 15 to 50 feet in thickness. It consists of yellowish-gray, fine-grained lenticular sandstone, gray clay shale, and thin carbonaceous shale beds. East of the lease areas near the outcrop of the coalbed, the Wasatch is red clinker or scoria, a baked and fused gravelly textured rock that formed from the shale, siltstone, and sandstone when the underlying coal burned.

Alluvium in the lease areas is composed of unconsolidated sand, silt, and clay deposited along the intermittent streams and is generally less than 10 feet thick.

Regionally the strata dip about 1 1/2 degrees to the west. A very low amplitude, north trending, local anticlinal fold is exposed in the mine pits, otherwise the rocks appear horizontal.

Coal

The Wyodak mine has produced coal from two open pits, one to the north of the highway, railroad, and power plant, and the other to the south (Figure 2, Chapter I). The coal, type named the Wyodak bed for this site, averages about 85 feet thick, but ranges from 60 to 102 feet in thickness (Figure 3). Locally where erosion has removed the upper part of the bed, the remaining coal is about 40 feet thick. In the north pit two coalbeds,

Figure 3

The Wyodak Coal Bed, About 90 Feet Thick, at Wyodak, Wyoming.

each about 40 feet thick, are separated by carbonaceous clay shale less than one foot thick. In the south pit the upper bed averages 32 feet thick and the lower about 52 feet thick; they are separated by shale that thickens eastward from a few feet to about 25 feet.

Quality of the coal

Coal produced at the Wyodak mine is classified as subbituminous C. Proximate analyses dated 1963 submitted by Paul Weir Company for samples of coal from the Wyodak mine are as follows:

	Upper Bed	Lower Bed	Average
Moisture	27.83	29.3	28.56
Ash	6.49	5.37	5.93
Sulfur	.65	.36	.50
Fixed carbon	33.50	34.89	34.20
Volatile matter	32.17	30.31	31.24
Btu	8,302	8,208	8,255

Table 2 shows coal analyses made by the U.S. Bureau of Mines in 1973 on samples collected at the Wyodak mine. Major oxide composition of the ash of coal samples from the Wyodak mine as analyzed by the U.S. Geological Survey, 1973, are shown in Table 3; U.S. Geological Survey analyses for selected trace elements in the same samples are reported in Tables 4 and 5. No unusually high concentrations of trace elements are apparent in the samples and the values are comparable to other subbituminous coals of the West.

Quantity of the coal

The Wyodak Resources Development Corporation estimates that it either owns or has lease of federal coal reserves amounting to 50 million tons of recoverable coal. The federal coal lease W-073289 in the area of the south

pit is 240 acres. Assuming an average thickness of 84 feet of coal and a weight of 1,770 short tons per acre-foot, the original reserves of coal on the federal lease would be 35,683,000 short tons. Adding to this the 200 acres of privately owned, variably thick coal in the south pit area (24,910,000 short tons), the original reserve of coal would be 61,593,000 short tons. According to the mine plan for the south pit (Figure 3, Chapter I), about 62 acres or 6,584,000 short tons of variably thick coal have been mined out leaving a remaining reserve of 55,000,000 tons. The remaining recoverable coal reserve in the south pit area is about 52,250,000 short tons, assuming 95 percent recoverability.

Federal coal lease W-0111833 in the north pit area is 80 acres. Assuming an average thickness of 80 feet of coal and the same weight, 1,770 tons per acre-foot, the original reserve of federal coal in the area of the north pit is 11,328,000 short tons. About 878,000 tons have been mined from the north pit; the remaining reserve is 10,450,000 short tons; remaining recoverable reserve is 9,928,000 short tons based on 95 percent recoverability.

Wyodak Resources Development Corporation also has a federal coal lease W-0313666 of 1,560 acres just north of the north pit. Coal reserve data have not been calculated for this lease because the company has not proposed any immediate future mining plans there. More than an adequate supply of coal is available by increasing production from only the south pit in order to meet the demands of the proposed larger power generating plant.

Other minerals

No uranium or mineable minerals, other than coal, are known to occur on the Wyodak leases. Clinker crops out on the east edge of the leases and

has been used for road metal and ballast. Sand and gravel occurs sparingly in the alluvium.

Oil and gas

The Wyodak Resources Development Corporation's federal coal lease in T50N, R71W presently has no known oil or gas test wells. Oil and gas tests to any formation within the area could be applied for at any time.

Sample No.	D 160987		D160983		D160978	
USBM Lab. No.	K-12882		K-12881		K-12880	
Sample interval	Tipple		10 feet *		5 feet **	
	As received	Moisture and ash free	As received	Moisture and ash free	As received	Moisture and ash free
Moisture	27.1	--	10.4	--	25.9	--
Volatile matter	31.5	46.7	40.9	50.7	32.2	46.9
Fixed carbon	35.9	53.3	39.7	49.3	36.3	53.1
Ash	5.5	--	9.0	--	5.6	--
Btu	8,530	12,650	10,280	12,760	8,570	12,500
Hydrogen	6.6	5.3	5.6	5.6	6.4	5.1
Carbon	49.5	73.4	58.8	73.0	50.2	73.2
Nitrogen	.7	1.1	.8	1.0	.7	1.1
Oxygen	37.4	19.7	24.9	19.3	36.6	20.1
Sulfur	.3	.5	.9	1.1	.5	.5
Sulfate	.01	.01	.09	.11	.08	.11
Pyritic	.07	.11	.09	.11	.09	.14
Organic	.22	.33	.70	.87	.20	.30

* 13 to 23 feet below top of bed.
** 42 to 47 feet below top of bed.

Table 2

Proximate, ultimate, Btu, and sulfur analyses of coal samples from the Wyodak Mine, Campbell County, Wyoming (All analyses except Btu are in percent. Analyses by Coal Analysis Section, U.S. Bureau of Mines, Pittsburgh, Pennsylvania.)

Table 3

Major oxide composition of the laboratory ash of 12 coal samples from the Wyodak bed at the Wyodak Mine, Campbell County, Wyoming (Analyses in percent; T, indicates top of bed; analyses by U.S. Geological Survey, Denver, Colorado.)

Sample No.	Sample Interval (ft)	Ash	SiO_2	Al_2O_3	Na_2O	K_2O	CaO	MgO	P_2O_5	Fe_2O_3	SO_3
D160987	(Tipple)	6.42	30.	13.	1.55	0.5	21.	5.05	1.7	3.3	13.
D160986	(Shot-pile)	8.82	28.	18.	.46	.5	16.	4.15	1.5	2.8	19.
D160985	3.(T)	4.90	17.	12.	.87	.7	24.	6.15	<.05	7.3	21.
D160984	10.	7.54	28.	17.	.60	1.1	16.	4.25	.5	5.2	20.
D160983	10.	10.6	33.	15.	.44	.8	14.	3.25	1.2	4.0	18.
D160982	10.	6.80	21.	13.	1.00	.6	23.	5.80	.7	3.8	21.
D160981	0.5	84.9	63.	26.	.13	1.7	0.5	.80	.07	1.7	0.3
D160980	3.5	9.78	33.	14.	.83	.7	19.	4.90	1.2	3.1	13.
D160979	5.	10.0	41.	15.	.71	1.1	15.	3.80	.6	2.5	10.
D160978	5.	6.78	20.	10.	1.42	.5	27.	8.00	1.1	3.2	15.
D160977	5.	7.34	24.	10.	.88	.7	25.	6.20	.6	4.6	14.
D160976	5.	6.20	26.	11.	1.31	.5	24.	6.85	2.1	3.7	10.

Sample No.	Thickness of sample interval (ft)	As	Cd	Cu	F	Hg	Li	Pb	Sb	Se	Th	U	Zn	Ash (percent)
D160987	(Tipple)	1	< 0.1	7.7	30	0.081	1.6	5.6	0.1	0.6	< 1.5	0.6	4.2	6.42
D160986	(Shot-pile)	2	.15	22.0	40	.108	4.1	5.7	.3	1.4	< 1.5	1.5	12.5	8.82
D160985	3.(T)	2	< .1	3.3	30	.055	.7	3.9	<.1	.4	< 1.5	< .2	5.5	4.90
D160984	10.	3	.16	10.0	40	.214	2.2	5.7	.2	1.4	< 1.5	.6	7.1	7.54
D160983	10.	2	< .1	20.4	50	.176	4.0	7.1	.3	.8	3.1	.9	15.4	10.6
D160982	10.	1	< .1	8.3	40	.048	2.0	5.7	.1	.6	< 1.5	.6	5.6	6.80
D160981	.5	2	< .1	51.	200	.150	49.	< 40.	.5	.6	7.9	3.2	25.	84.9
D160980	3.5	1	< .1	9.8	50	.104	4.2	8.1	.3	1.0	< 1.5	.5	7.5	9.78
D160979	5.	1	< .1	12.4	40	.068	3.6	8.2	.3	.9	< 1.5	.9	8.0	10.0
D160978	5.	1	< .1	7.6	40	.064	1.1	6.2	.3	.4	< 1.5	.5	3.3	6.78
D160977	5.	< 1	< .1	5.6	30	.063	1.3	7.2	.2	.3	< 1.5	.5	4.4	7.34
D160976	5.	< 1	< .1	3.8	30	.050	1.9	6.0	.1	1.9	< 1.5	.5	3.5	6.20

(Values for Cd, Cu, Li, Pb, and Zn are calculated from analyses on ash of coal. T. indicates top of bed.)

Source: USGS

Table 4

Quantitative Determinations (in parts per million) for 12 Trace Elements in 12 Coal Samples for the Qyodak Bed at the Wyodak Mine, Campbell County, Wyoming.

Table 5

—Semiquantitative spectrographic analyses, in parts per million, for 19 trace elements in 12 coal samples from the Wyodak bed at the Wyodak Mine, Campbell County, Wyoming.
(All values have been calculated from analyses on ash of coal. Analyses by U.S. Geological Survey, Denver, Colorado.)

Sample No.	Sample interval (ft)	B	Ba	Be	Co	Cr	Ga	La	Mn	Mo	Nb	Ni	Sc	Sn	Sr	Ti	V	Y	Yb	Zr
D160987	(Tipple)	30	200	< 0.15	1.	5	2	< 5	10	0.5	1.	2.	1.	< 0.5	50	200	10	2	0.2	10
D160986	(Shot-pile)	50	200	.3	3.	7	3	< 5	200	1.	2.	7.	3.	< .5	50	500	30	5	.7	20
D160985	3.(T)	30	150	< .15	1.5	2	1	< 5	50	.3	< 1.	3.	.7	< .5	20	100	7	2	.2	5
D160984	10.	50	150	.2	2.	5	2	7	50	.5	1.5	5.	1.	< .5	20	200	15	1	.1	10
D160983	10.	30	200	.3	2.	7	3	10	30	.7	2.	7.	2.	< .5	30	500	20	5	.5	15
D160982	10.	30	200	< .15	1.	5	2	< 5	20	.5	< 1.	5.	1.	< .5	30	200	10	2	.2	10
D160981	.5	50	500	< .15	< .5	50	20	< 5	50	< .5	20.	15.	15.	< .5	150	5,000	150	<1	2.	150
D160980	3.5	20	300	< .15	2.	7	3	< 5	15	.7	< 1.	3.	1.5	< .5	50	300	15	2	.3	15
D160979	5.	20	200	< .15	1.5	10	3	< 5	15	.7	< 1.	3.	1.5	< .5	30	300	20	3	.3	15
D160978	5.	20	300	< .15	.7	2	1.5	< 5	10	.5	< 1.	2.	1.	< .5	50	200	7	2	.2	10
D160977	5.	20	300	< .15	.7	2	2	< 5	20	.5	2.	2.	.7	< .5	50	200	5	1.5	.2	10
D160976	5.	30	300	< .15	1.	2	2	< 5	10	.7	3.	2.	1.	< .5	70	200	5	2	.2	10

Water Resources

Ground water

Formations at the Wyodak mine sites that contain aquifers within about 3,000 feet of the land surface include, in descending order below the coal, the Fort Union Formation, Lance Formation, and Fox Hills Sandstone. Underlying the Fox Hills are several formations consisting mostly of shale not considered as aquifers of any importance in the Wyodak vicinity. The coal overburden in the vicinity of the mine consists of the Wasatch Formation. Because of the lenticular nature of the Wasatch and Fort Union, rock dips are not easy to determine. Based on the depth to the Fort Union at the Gillette municipal water-well field, the Fort Union dips about 100 feet per mile westward, somewhat less dip than has been reported in some literature. The lithologies of the formations down to and including the Fox Hills consists predominantly of alternating and lenticular beds of sand, shale, and coal. Because the sand and coalbeds have greater permeability, these beds are usually considered as aquifers, but many separate water levels are present in the sequence of rock. Work recently done by the Northern Great Plains Resource Program shows that the water level in the coal is different from water levels in the overlying Wasatch aquifers. Several water levels are commonly present in the Wasatch because of the lenticular nature of the beds.

Water movement

Movement of water in rocks overlying the coal in the Wyodak vicinity is in an eastward direction with a small component toward Donkey Creek. Water-level data to determine movement of water in the coal is not available. Natural movement of water in the coal would probably be either eastward toward the coal outcrop or northward toward the upper reaches of the Little Powder River.

Pumping at the mine of about 200 gallons per minute (gpm) for dewatering shows that some discharge is occurring at the mine pit, either naturally or from local change in gradient because of mine dewatering. The potentiometric gradient in the coal is probably flat, 10 to 20 feet per mile, compared to the gradient in the overlying aquifers which is about 75 feet per mile.

Water use

Pumping for dewatering at the mine is at the rate of 207 gpm based on a 24-hour pumping period (about 300,000 gallons per day). For about six months of the year, the water is used for road-dust suppression. For about three months, one half of the water is used for dust suppression and the remaining water is discharged into Donkey Creek. For the remaining three months of the year, all the water pumped is discharged into Donkey Creek. As mining operations are increased southward and eventually downdip toward the west, longer road distances will be required for hauling the coal and more of the water will be used for dust suppression. However, as mining progresses, increased ground-water discharge can be expected to occur in the enlarged pit areas.

The power generating plant will use dry cooling towers, thus water requirements will be greatly reduced. Treated sewage from the City of Gillette will be used as a primary source of water. The treated sewage water would be adequate for makeup water, boiler blowdown, scrubber water, and maintenance water. New water wells drilled to the Fox Hills Sandstone during the summer of 1973 will supply water for general and personal uses and for domestic purposes for several resident mobile homes near the plant site.

Scrubber water with fly ash will have to be treated before recycling. Waste from the treated water would be discharged to a settling pond.

Surface water

Drainage and streamflow

The surface of the area leased by Wyodak Resource Development Corporation is drained by tributaries of Donkey Creek. Donkey Creek has a drainage area of 99 square miles upstream from the leased area. The stream was ephemeral or intermittent in its natural state; however, sewage effluent from Gillette presently causes perennial flow. The course of the stream has been diverted around the south pit which is presently being mined. About 60 percent of the leased area drains into Donkey Creek; the remaining area drains into shallow closed basins which have no apparent outflow.

Streamflows of the area are highly variable; thus, surface-water supplies are not dependable. Minor tributaries of the area commonly have periods of several years with no flow. The major part (75 percent) of annual runoff occurs during the spring and summer months, generally as a result of convective storms.

Surface water uses

Major use of surface water is for consumption by domestic and wild animals. Several stockponds are located on minor tributaries, and detention and retention of flows is afforded by these man-made features.

Donkey Creek is a tributary to the Belle Fourche River, whose flows are allocated by interstate compact agreement. Any proposed uses of surface waters must take the compact agreement and downstream water rights into consideration. The compact agreement specifically states that no reservoir built solely to use water allocated to Wyoming shall have a capacity in excess of 1,000 acre-feet. During most years, downstream adjudicated water rights require

the entire runoff. Thus, the potential of using Donkey Creek to develop a water supply for the operations of the leased area is minimal.

Erosion and sedimentation

Erosion on the leased area is low in relation to other parts of the Eastern Powder River Coal Basin due to a better grass cover. Very little head-cutting or gulley formation is present.

Water quality

Samples collected from the Belle Fourche River downstream from the confluence of Donkey Creek are not representative of the water quality in Donkey Creek during low flow due to the sewage effluent from Gillette. During higher flows when a larger portion of the water is from runoff, water quality should be similar to the water quality sampled on the Belle Fourche River near Moorcroft. Dissolved solids concentrations in the Belle Fourche River from 1954 to 1957 ranged from 162 milograms per liter (mg/l) at 132 cfs to 2910 mg/l at 0.3 cfs.

Vegetation

Vegetation on and surrounding the Wyodak coal property is made up of short grasses intermixed with various amounts of big sagebrush. Because of domestic livestock grazing for many years, plant communities on and adjacent to the property are in an intermediate stage of plant succession. Little successional change would be expected with continued livestock grazing.

While plant communities have not been mapped for the area, some broad vegetation communities have been delineated on Figure 4 based on identified soil units. These are described below and are keyed to Figure 4 with legend numbers.

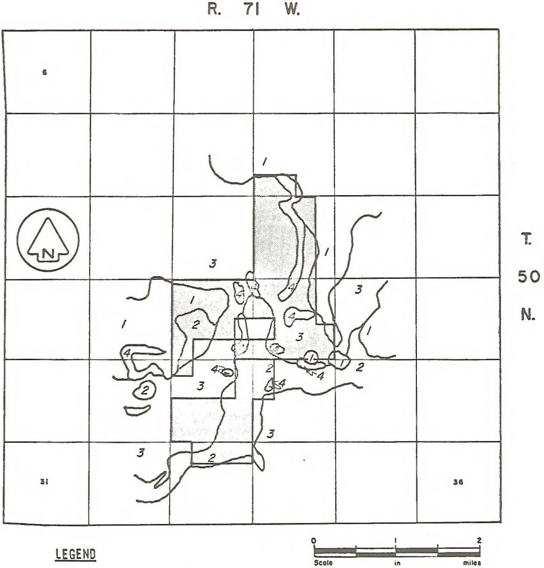
The largest community (#3) is a big sagebrush-needleandthread-blue grama type and covers approximately 1,090 acres of the 2,080-acre coal property. This type is found on the rolling to gently rolling uplands with loamy to clay loam soils.

A bluebunch wheatgrass community (#1) of about 330 acres within the property is found on the shallow and stony soils composed of rolling to hilly scoria land.

About 440 acres of an inland saltgrass-western wheatgrass community (#2) are found in the stream bottoms on clay to clay loam soils.

The balance of the area (220 acres) is occupied by a big sagebrush-western wheatgrass-blue grama community (#4) which is found on the steep rough broken areas in the northern part of the property.

Vegetation on and adjacent to the area is considered to be in fair to good range condition for all communities. Estimated live vegetation ground cover (percent of ground covered with live vegetation) ranges from 10 to 35 percent. Such a sparse vegetative cover reflects the short growing season and semiarid climate which has an average annual precipitation of about 14 inches.



LEGEND

1 Bluebunch Wheatgrass

2 Inland Saltgrass/Western Wheatgrass

3 Big Sagebrush/NeedleandThread-Blue Grama

4 Big Sagebrush/Western Wheatgrass-Blue Grama

Boundary of Wyodak Coal Property

Source: After Soils Data, USDA, SCS, Soil Survey of Campbell County, Wyoming, July, 1955, Soil Map Sheet No. 3

Figure 4

Vegetation Community Boundaries (Wyodak Coal Property)

Aquatic vegetation is absent on the property but may be found in adjacent Donkey Creek, an intermittent stream, which flows easterly along the south part of the area. Some of the plant species found in the area include:

Symbol	Common Name	Scientific Name
Agsm	western wheatgrass	*Agropyron smithii*
Agsp	bluebunch wheatgrass	*Agropyron spicatum*
Ansc	little bluestem	*Andropogon scoparius*
Bogr	blue grama	*Bouteloua gracilis*
Cafi	threadleaf sedge	*Carex filifolia*
Dist	inland saltgrass	*Distichlis stricta*
Hoju	foxtail barley	*Hordeum jubatum*
JUNC	rushes	*Juncus* spp.
Kocr	prairie junegrass	*Koeleria cristata*
Orhy	Indian ricegrass	*Oryzopsis hymenoides*
Popr	Kentucky bluegrass	*Poa pratensis*
Pose	Sandberg bluegrass	*Poa sandbergii*
Stco	needleandthread	*Stipa comata*
ASTR	milkvetches	*Astragalus* spp.
LUPI	lupines	*Lupinus* spp.
LYGO	skeleton plant	*Lygodesmia* spp.
PHLO	phlox	*Phlox* spp.
PSOR	scurfpea	*Psoralea* spp.
Arca	silver sagebrush	*Artemisia cana*
Arfr	fringed sagebrush	*Artemisia frigida*
Artr	big sagebrush	*Artemisia tridentata*
Oppo	plains prickly pear	*Opuntia polyacantha*
Save	greasewood	*Sarcobatus vermiculatus*

Archeological and Paleontological Values

The Wyodak lease area is not part of the areas which typically characterized evidence of early man; however, this does not mean that the Wyodak lease area is without cultural resources. This area has very good probability of cultural resources, especially in view of the easterly flowing Donkey Creek. Donkey Creek, being a permanently running stream, would have attracted both man and animal to its banks. The existence of cultural resources such as teepee rings and scatterings of tool stones, chipping and broken arrowheads, on the Carter lease eight miles northwest, indicates that prehistoric man was, in fact, in the area. This is the case with much of the Powder River Basin.

Nothing can be said about archeology of the Wyodak lease until an archeological survey has been conducted by a professional archeologist. The Wyodak mining plan states there is no evidence of archeological values.

Historical Values

A literature review and site examination of the Wyodak lease was made by a professional historian, resident in the Powder River Basin.

The most significant party of record to skirt the area was the westbound force of John Jacob Astor's American Fur Company under the leadership of Wilson Price Hunt. They moved swiftly through the region in the summer of 1811. Their route is reasonably easy to follow from Hunt's journal, but they were traveling with saddle horses and pack animals and left no trail of consequence. Their nearest approach to the Wyodak site was approximately 20 miles north.

The coal mine and the proposed mine site do not contain historic buildings as such and no other historic activities or events have occurred here.

Aesthetics

While the land east of the Wyodak lease falls steeply into a wide valley bottom, the lease itself is on two broad, gently sloping ridges with a shallow valley between.

The vegetative texture is soft appearing from the rolling grass and sage covered hills. Sagebrush is fairly dominant and quite evenly distributed. The color is the grey-green of the sage mixed with the grass-green in the summertime and brown during the winter months. The exposed soil is generally the soft brown or yellow ocher.

The entire lease is small, with not much relief, blending easily with the surrounding land. The gentle slopes, even texture, and generally monotone colors do not provide very exciting scenery. The major scenic value of this natural site is its continuity with the landscape.

There are few intrusions on the lease. However, the intrusions created by the present mine, the power plant, and associated facilities effectively negate any scenic values.

Wildlife and Fish

A more extensive description of existing wildlife resources in the regional study area is found in Chapter IV, Part I. Site characteristics having broad applicability are also reviewed in Part I. Common and Latin names of vertebrate wildlife species known or suspected to occur in the Eastern Powder River Basin (and this lease area) are found in Tables 29 to 32, Appendix C.

Big game

Pronghorn antelope

The entire lease area provides seasonal habitat for numerous small groups of antelope (10 to 20 per group). Section 21 is especially important habitat in the lease area. Relatively small size, heavy livestock use, human activity, and tight fencing have reduced the overall value of this lease area for antelope. Specific harvest data concerning antelope in this lease area are not available. Major forage species include big sagebrush and rabbitbrush during all seasons and a variety of forbs during spring and summer. Average concentrations are approximately 5 to 10 antelope per section or about 25 animals.

The lease area does not constitute quality deer habitat. Light and irregular use is made by mule deer with small habitat size; lack of cover, and considerable human activity combine to create limiting factors. Seasonal densities of about three deer per section periodically use the area north of the existing power plant. It is unlikely that sport harvest occurs on this lease area. Big sagebrush is the primary forage species of value to mule deer.

Other mammals

Predators and furbearers

Little information concerning specific predator use or population trends in this lease area is available. Predators most common to the area are coyotes, red foxes, raccoons, badgers, striped skunks, and bobcats. Prey species include ground squirrels, pocket gophers, prairie dogs, rabbits, and mice along with occasional insects, lizards, and grouse. Harvest by ranchers exercising a degree of predator control efforts is slight.

Beaver and muskrat are believed to occur on the lease area. Beaver and muskrat are directly dependent upon reliable water and riparian vegetation associated with it.

Rabbits and hares

Two species of hares (jackrabbits) and two species of rabbits (cottontails) are likely to be found on this lease area. The white-tailed jackrabbit is fairly common, while the presence of black-tailed jackrabbits on the lease area is not certain. They are present in modest numbers near the lease area. Cottontails found here are desert cottontails although the mountain cottontail may also be present. As with jackrabbits, populations of cottontails vary considerably from year to year. An average population density of 148 cottontails and 100 jackrabbits is estimated for the lease area.

Rodents

Two known colonies of blacktail prairie dogs occupy about 30 acres of the lease area lying south and west of the mine pit located in the S½, section 28, T50N, R71W. They are separated by a low hill. Prairie dog colonies have special significance because of their relationship to black-footed ferrets.

A variety of rodents occur on this lease area. Species include the least chipmunk, thirteen-lined ground squirrel, northern pocket gopher, Wyoming pocket mouse, Ord's kangaroo rat, western harvest mouse, deer mouse, and northern grasshopper mouse.

Results of small mammal trapping studies on the Carter lease area, about seven miles to the northwest, bear direct application to this lease area where similar habitat exists. Population and species abundance levels which may occur on the Wyodak lease are:

	Catch per 100 Trap Nights	
Species	Shrub-grass type	Grassland type
Deer mice	6.2	1.0
Harvest mice	1.5	.5
13-lined ground squirrel	.5	.8
Grasshopper mice	.07	.35
Least chipmunk	.09	None
Pocket mice	.06	None
Others	.05	None

Small-footed myotis, long-legged myotis, and western big-eared bat may occur on the lease area.

Upland game birds

Sage grouse

Sagebrush habitat, especially in the northern part of the lease area, is utilized intermittently by sage grouse. Estimated seasonal densities of five per section probably occur although the area is generally a low

concentration area. Although the sage grouse is a game species, harvest on this lease area is unlikely.

Hungarian (gray) partridge

This species occurs in surrounding areas. Their presence on the lease area is likely. A variety of habitat types satisfy living requirements for the "Hun."

Waterfowl and shorebirds

Most significant habitat is limited to small stockponds and an intermittent pond in the northwest corner of section 28. These ponds also serve as temporary resting and feeding areas for migrating waterfowl. The intermittent pond in section 28 provides reliable water only in the spring. Most common species are ducks and include the mallard, gadwall, American widgeon, and green-winged teal.

Other birds

Raptors

Raptors periodically found in the lease area include the red-tailed hawk, rough-legged hawk, Swainson's hawk, and American kestrel. It is not known if nesting habitat is available in the lease area. Golden eagles increase in numbers during the winter months. Other species which may occur are the ferruginous hawk, marsh hawk, great-horned owl, and short-eared owl. Birds, small mammals, and insects are the mainstay diet of raptors frequenting the area.

Song birds

Little data concerning the occurrence of song birds in this lease area are available. As many as 100 species may be present at various times of the

year. One of the most common species here is the western meadowlark (usually migratory) which feeds primarily on insects. Horned larks, yearlong residents, feed on insects and small seeds. Lark buntings, another migratory species, feed primarily on seeds except during the nesting season when they switch to insects. Black-billed magpies are yearlong residents of the general area.

Fish

There are presently no waters capable of supporting fish populations.

Reptiles and amphibians

While no reptiles or amphibians have been actually recorded as occurring on the lease area, several reptile species have been identified in the immediate region several miles to the northwest in similar habitat (Carter Oil Company 1973a, p. 25). These include the short-horned lizard, yellow-bellied racer, bullsnake, milk snake, and prairie rattlesnake. Amphibians which are probably present in the limited habitat of the lease area will be near the temporary ponds and intermittent stream courses. Species include the leopard frog, tiger salamander, and great plains toad. Others which may be present include the chorus frog, Woodhouse's toad, and the plains spadefoot toad. No documented population densities, trends, detailed distributions, etc., exist for either reptiles or amphibians.

Invertebrates

Local insect populations include an abundance of grasshoppers, beetles, ants, wasps, bees, butterflies, and moths. A variety of spiders is also present. These representative groups and others present include plant eaters, scavengers, predators, and parasites. Many species of plants depend on insects for pollination.

Threatened species

Black-footed ferret

This rare mammal has not been sighted on this lease area although its presence is possible. Two prairie dog colonies are on this lease area. Because ferrets have been reported in the Powder River Basin in recent years, all prairie dog colonies here must be considered potential ferret habitat. The presence of prairie dog colonies in nearby surrounding areas increases the likelihood of ferrets in the colony on this lease area.

Peregrine falcon

Occurrence of this species on the lease area is highly likely during period of migration.

Prairie falcon

Not an endangered species, the falcon is nevertheless rare in Wyoming. While no prairie falcons have been sighted on this lease area, they are known to be present in the Powder River Basin.

Recreation

Limited big game and upland game hunting occurs on the Wyodak lease. It is estimated that less than 100 hunter days are spent annually on the lease. Some varmit hunting may occur on the southern lease (existing mine) where a prairie dog town is located.

Some rolling terrain occurs on the Wyodak lease that may be attractive to local motorcyclists. However, no qualities exist which greatly distinguish it from the surrounding terrain. Some organized motorcross racing (motorcycles) is held on private land near the present Wyodak mine. The location is apparently used more for convenience than for any peculiar values since it lies five miles from Gillette.

Local groups contacted indicate no known concentrations of collectable gemstones or petrified wood on the lease.

Frequent antelope viewing opportunities exist both from on and off U.S. Highway 14-16. There are no special opportunities for observing birds of prey, waterfowl, upland game birds or wild horses. Prairie dogs can be seen in a well-developed town on the present-day mine and east of Wyodak.

The Wyodak strip mine and plant adjacent to the lease area are of interest especially to nonresidents passing through the region on U.S. Highway 14-16. This will become more significant when Interstate Highway 90 crosses the mine and travelers increase.

Agriculture

Livestock grazing

Four ranching operations currently make use of the surface resources of lands included in the Wyodak coal lease and mining plan. Two thousand and eighty acres are included in the lease, and Wyodak has added another 160 acres to the total plan for facilities. The ranching uses include livestock grazing and associated cropping. Of the 2,240 acres in the mining plan, Wyodak owns 1,480 acres, the State of Wyoming owns 320, and the remaining 440 acres are owned by three private individuals.

Ranch operation A

There are about 3,000 acres in this operation and the Wyodak lease is under 1,270 acres. The private individual owns 320 acres of the area under lease, and the remainder is owned by Wyodak or the State of Wyoming. One hundred fifty-five acres are seeded crested wheatgrass pasture, 120 acres are used for hay production, and the remainder is native range that is rated at four acres per animal unit month. This ranch is used for an 80-cow herd. Four reservoirs and one well are used for livestock water. Two miles of interior fence and 7 3/4 miles of boundary fence occur on the lease land.

Ranch operation B

There are over 7,400 acres in the ranch operation and the coal lease is under 440 acres. Of the 440 acres, 40 are owned by the ranch operator and the remainder is owned by Wyodak. All of the land is used for livestock grazing with the exception of approximately 65 acres that has been open pit mined by Wyodak. This is a continuing operation that mines about four acres annually. The only range improvement is the highway right-of-way fence. U.S. Highway 14 and 16 passes the north end of this ranch unit. There are no water

developments on this parcel, but Donkey Creek runs through the southern edge. It is not a true perennial stream but has become so because of the Gillette sewage system outflow. Water quality is not acceptable because of the level of effluent. This range is rated at three acres per animal unit month of forage.

Ranch operation C

This ranch operation is based on 2,280 acres and the Wyodak lease lies under 80 acres. The 80 acres is all native range and is rated at four acres per animal unit month of forage. There isn't any water on this tract and the only improvement is one-half mile of boundary fence on the southern edge. This ranch operation is leased to an operator who owns other lands. The total size of the ranch is not known or the numbers and class of livestock managed.

Ranch operation D

This is a seasonal lease arrangement with Wyodak and is based on about 350 acres. Yearlings are purchased annually and grazed on the Wyodak lands. Wyodak uses the remainder or about 100 acres for facilities and an old, open pit mine. Of the 350 acres, 290 are included in the coal lease. The remainder is facility lands not currently being utilized. All improvements on the grazing lands are Wyodak owned. The operator maintains what facilities he needs. These lands are rated at 3.5 acres per animal unit month.

Farming

Farming operations on the area included in the Wyodak coal lease are not significant. There is no irrigation and summer fallow must be used to achieve an economical yield on small grain.

One hundred twenty acres of hay is cropped on one farm-ranch operation. The yield is approximately one ton per acre. The same operator may raise a crop of small grain every few years. The crop practice consists of reseeding pasture to small grain the first year and then to grass the following year. Crops are barley or wheat and the yields average about 30 bushels per acre.

The farm has a total of 155 acres of seeded pasture so the grain acreage planted is much less.

Transportation

The Wyodak coal lease is located approximately five miles east of Gillette and north of U.S. Highway 14 and 16. This stretch of highway is fairly heavily traveled with over 2,000 vehicles per day (Wyoming State Highway Commission 1972). Highway I-90 will eventually take over the traffic from U.S. 14 and 16 upon its completion in the latter half of 1975. The new highway will be located north of the existing U.S. 14 and 16 which will remain as a frontage road.

One county maintained road crosses a small portion of the southeast corner of the north lease area and only one other identifiable graded dirt road was noted. There are a limited number of unimproved dirt roads throughout the lease area. Traffic flow figures on these roads are not available but are estimated to be light and used chiefly for access to the existing Wyodak mine, ranching operations, and oil well operations.

One of the pipelines shown on Figure 82, Chapter IV, Part I, crosses the north lease area. A number of electric transmission lines emanate from the Black Hills Power Plant at Wyodak, of which at least five cross some portion of the lease area.

Two new power generating facilities are scheduled to go into operation at Wyodak in 1977 and 1982. The proposed transmission lines associated with these plants are shown on Figure 83, Chapter IV, Part I.

Socio-Economic Conditions

Employment

Total employment within Campbell County increased by 111 percent (2,526 jobs) during the 1960 to 1970 interval (Table 46, Appendix C). This increase resulted from significant employment increases to the sectors of petrochemicals (1,140 jobs) and other residentiaries (1,236) of 509 percent and 110 percent, respectively. This is a direct result of the oil boom which occurred within Campbell County in the 1960's. Petrochemicals and agriculture are the top two employment sectors within the county. Coal mining, power generation, and railroad sectors combined comprise only 1.7 percent of total county employment. Presumably as a secondary result of the 1960's oil boom, the other manufacturing sectors (manufacturing not related to energy mining or fuels) experienced a large percentage growth of 628 percent but still remains a moderately low numerical employer (131) in the county. The rate of 2.6 percent unemployment is low.

Wyodak presently employs 28 people at their existing coal mine and 22 people at their existing power plant.

Income

The median ($11,303) and mean ($12,949) incomes of Campbell County are the highest in the eight-county region. The introduction of oil and coal development with associated high incomes have contributed to the generally high income levels. While 60.6 percent of a total of 3,085 families had incomes which exceeded $10,000 in 1970; 26.2 percent of the families had incomes greater than $15,000 and 10.2 percent of total families had incomes less than $5,000. This percentage of families with less than $5,000 is nearly 50 percent less than

the study area and state averages. Average annual salaries at the existing Wyodak facilities are about $10,400.

Other existing socio-economic conditions (population, housing, education, etc.) are in Chapter IV, Part I.

CHAPTER III

PROBABLE IMPACT OF PROPOSED ACTION

Total development of the Wyodak mine property will involve 2,080 acres. An estimated 140 acres (120 mined - 20 facilities) have already been disturbed. The mine has been in existence since 1925. A 30-megawatt (MW) air-cooled powerplant is currently in operation at the mine site. The mine property includes federal lease coal as well as private coal.

The impact analysis covers the remaining 1940 acres to be mined, a 330-MW air-cooled plant to be completed by 1977 and a 450-MW air-cooled power plant projected to be in operation by 1982 and 44 miles of transmission line to be built in the study area in 1976-1977. As the mine and plant are located on the main railroad line, only a short spur will be required (670') for the warehouse.

Air Quality

Current mining operations, removing approximately 0.7 million tons per year, are adding dust and coal dust to the atmosphere causing a reduction in air quality. Operation of the 30-MW air cooled Neil Simpson Station is contributing to a reduction in ambient air quality. Estimated yearly emissions from this plant (<u>with controls</u>) are: particulates - 1,518 tons, nitrogen oxides - 920 tons, and sulfur dioxide - 718 tons.

Expansion of mining activities on this site will create additional impacts on air quality. The present production rate is scheduled to increase from 0.7 million tons to 2.5 million tons in 1977 and to 5 million tons in 1982. The present level of mining disturbs an estimated 5 surface acres per

year and 137,200 cubic yards of overburden. At the 2.5 ton production level in 1977, the surface disturbance increases to about 18 acres and 490,000 cubic yards of overburden. In 1982, the surface disturbance will be approximately 6 acres and 980,000 million cubic yards of overburden.

Over the life of the mine (38 years or until 2012) an estimated 1,940 acres will be disturbed and 32.4 million cubic yards of overburden will be removed and handled. Removal of vegetation and disturbance of topsoil and overburden will expose fine-grained soil and parent material to wind action which is frequently quite strong. Soil particles will be lifted by the wind and carried into the atmosphere, causing a reduction in air quality and reducing visibility during periods of high wind. Coal dust from crushers, trucks, coal piles, and loading operations will also pollute the air during windy periods. Pollution from these sources may increase up to three-fold in 1977 and as much as seven times the present amount in 1982 when production increases to 5 million tons per year. From this point on it is assured that production and thereby air pollution from coal mining will remain at a constant rate until the coal is exhausted.

Expansion of operations will also increase emissions of sulfur dioxide, carbon monoxide, nitrogen oxides, and hydrocarbons from mining equipment, increased train operations, and operation of vehicles by the increased population (1,100 by 1990) associated with the mine and power plants. As coal production is increased, more loose coal will be exposed, thereby creating the probability of an increase in accidental coal fires (from spontaneous combustion). These will add toxic vapors and particulates to the atmosphere. Increased human activity on and adjacent to the area also increases the chance of additional wildfires. Such fires would temporarily add smoke and particles to the air, further reducing air quality.

Construction of a new 330-megawatt (MW) power plant with a 400-foot stack will be completed and in operation by 1977. All of the old units except unit 5 (20 MW) of the Neil Simpson Station will be retired. The projected yearly emissions from the new 330-MW plant and unit 5, without controls and consuming 1.5 million tons of coal per year, could be: 84,000 tons of particulates, 14,250 tons of sulfur dioxide ($SO_2$2), and 13,500 tons of nitrogen oxides (NO_xx).

Another new air-cooled power plant is scheduled for construction and operation by 1982. This will be a 450-MW plant, requiring 2 million tons of coal per year, and could have yearly emissions, without controls, of 108,000 tons of particulates, 19,000 tons of sulfur dioxide, and 18,000 tons of nitrogen oxides. When the second new plant becomes operational, total yearly stack emissions (without controls) resulting from the area could be: 192,000 tons of particulates, 33,250 tons of sulfur dioxide, and 31,500 tons of nitrogen oxides. Even with controls, there could be a significant increase over present air pollution levels.

Trace elements contained in the coal burned by the Wyodak power plants may be released with stack emissions. These trace element emissions could have a detrimental effect upon soil, vegetation, animals, and man although little scientific information exists as to their effects upon the environment. An analysis of a coal sample taken from the tipple at Wyodak's mine (analyzed by the U. S. Geological Survey, Denver, Colorado) shows the following quantitative amounts (parts per million - ppm) of twelve trace elements: arsenic - 1 ppm; cadmium - less than 0.1 ppm; copper - 7.7 ppm; fluorine - 30 ppm; mercury - 0.081 ppm; lithium - 1.6 ppm; lead - 5.6 ppm; antimony - 0.1 ppm; selenium - 0.6 ppm; thorium - less than 1.5 ppm; uranium - 0.6 ppm; and zinc - 4.2 ppm.

(See the Minerals description of this part for other trace elements in coal from the Wyodak mine.)

Construction of the first power plant will involve surface disturbance of 30 acres and the second one will disturb an additional 30 acres. This will add additional dust and internal combustion engine emissions to the atmosphere. Total population increases associated with the mine (480 by 1990), first power plant (420 by 1990), and second power plant (200 by 1990) will add increased vehicle emissions to the air of the basin and particularly the Gillette area air basin.

During normal climatic conditions, the air pollutants originating from this site will be dispersed downwind (east and southeast) within a short distance and before reaching any center of population. However, when inversions occur (probability of 15 two-day episodes per year) onsite workers, as well as people in Gillette, could be seriously affected. Gillette could also be impacted from these pollutants during periods of easterly winds (which occur less than 10 percent of the time). During such occurrences, respiratory and heart conditions could be aggravated, asthmatics irritated, and lung diseases caused or worsened.

Offsite impact on air quality will result from construction of new powerlines. Two new 230-kv lines will be constructed from the 330-MW power plant scheduled for operation in 1977. These lines will be constructed to Buffalo, Wyoming, and Spearfish, South Dakota. They will involve partial or complete soil disturbance on approximately 1,012 acres within the two-county study area. This will temporarily add dust and vehicle emissions to the air. As this pollution will be occurring along a stretch of 44 miles, its impact on air quality will not be significant.

Topography

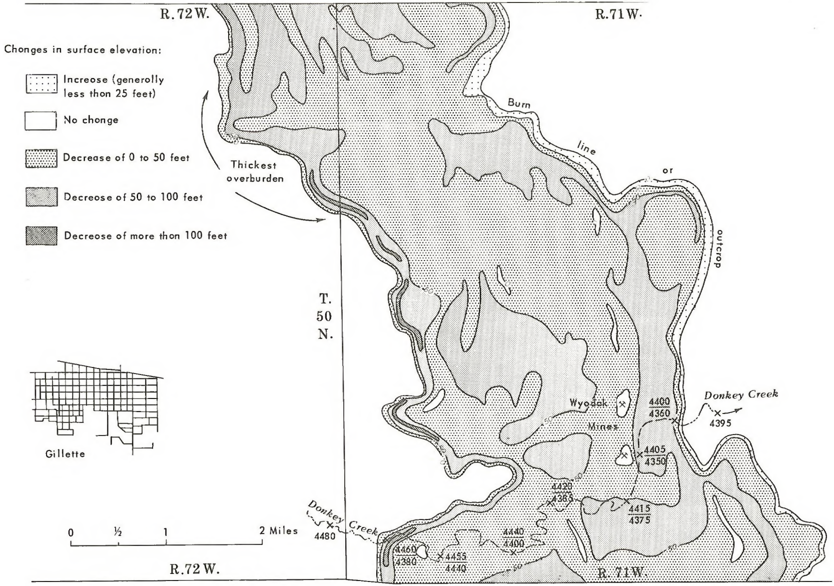
The topography surrounding the Wyodak mines probably will be impacted the greatest of any area in the coal mining district. This impact is caused mainly by thin overburden. Coal beds at the Wyodak mine range in thickness from 60 feet to 120 feet. Overburden thickness ranges from 25 feet to 150 feet. The decrease in altitude will range from a maximum of 103 feet to a minimum of 24 feet. Average drop in altitude for the entire area to be mined, where average coal thickness is 84 feet, and average overburden thickness is 35 feet, will be about 77 feet. Maximum decrease in altitude will occur in areas which have thick coal in relation to thin overburden.

East of Gillette, Wyoming, the township (T. 50 N., R. 71-72 W.) that includes the Wyodak mine is a good example of the interrelation of coal mining, minimum spoil, changes in ground slope and possible increased local erosion and deposition.

In the mine-reclamation model for reconstructing the topography of this township after coal mining, the following assumptions were made: no reshaping of spoils but only smoothing spoil piles; mining in 200-foot panels westward from the burnline or outcrop to the final highwall; smoothing the highwalls to 3:1 slopes; and smoothing margins. A value of 100 feet was assumed for the thickness of the coal. Figure 1 shows that the average altitude of land surface may be decreased between 50 and 100 feet for large parts of this township. This broad lowering of land surface ends in a long narrow trough on the west side, the remains of the final pits and highwalls. Smoothing and rounding of the spoil piles generally tends to create a more subdued, rolling topographic relief. Any cliff-like or abrupt topographic breaks now present on the area will be eliminated.

Figure 1

Changes in Ground Surface Altitudes Resulting From Surface Mining of the Wyodak Coal Bed (100 feet thick) East of Gillette, Wyoming, Modified From Keefer, 1974.



Donkey Creek drops about 80 feet at the highwall, then rises about 40 feet before it turns north, and finally rises another 40 feet at the burnline. Unless the channel of Donkey Creek is deepened east of the burnline, some ponding or formation of lakes will probably occur west of the burnline.

Because of the thickness of the coalbeds, topographic impacts will occur slowly. Since most of the coal is associated with thin overburden, little surface acreage has to be disturbed to mine large volumes of coal.

Soils

Mining will result in the destruction and mixing of the topsoil on all mined lands (1,940 acres) within the mining area. This will destroy all of the soil characteristics, micro-organisms and climatic relationships which have been established over a long geologic time span and destroy soil productivity for an indefinite time period. During the life of the mine (until 2012) approximately 1,100 acres of moderately productive agricultural soils identified as the Ulm (1,070 acres), Renohill (10 acres) and Terry (20 acres) soil types will be destroyed. The remaining 840 acres comprised of the Arvada (460 acres), Wibaux (200 acres) and Rough Broken Lands (180) would be impacted slightly because they are not suitable for agriculture and are low in productivity. In addition to the topsoil acreage which will be disturbed, approximately 3.2 million cubic yards of overburden or lower soil horizons will be removed and disturbed during the life of the mine. This will result in complete destruction of all soil horizons, parent material and soil characteristics and could result in bringing elements such as boron to the surface which may be toxic to plant growth. At the completion of mining operations the soil structure will be completely different from what exists today and productivity could be destroyed.

Upon expected completion of mining by 2012 approximately 43 percent (900 acres) of the soil surface will be permanently lost to reclamation or revegetation as adequate fill material will not be available for total reclamation and a partially filled pit of water will remain. Nearly 1,180 acres of disturbed soils will remain for rehabilitation and revegetation.

Mining operations and disturbance of soil surfaces will result in fine grained soil and parent material being exposed to wind and water actions. Soil permeability and infiltration rates will be reduced, increasing runoff,

soil erosion and sedimentation. Wind action, which is almost constant over the area, will cause fine soil, silt, and clay particles to be lifted into the atmosphere reducing air quality and adding to soil loss.

Construction of a 345-kv powerline (44 miles) will disturb about 1,012 acres of productive soils in the Renohill-Maysdorf-Ulm soil association No. 3 (552 acres), Wibaux association No. 7 (92 acres); Renohill-Cushman Association No. 9 (200 acres); Renohill-Shingle-Terry Association No. 10 (108 acres); and Tassel-Shingle-Otero-Terry-Olney-Kim Association No. 20 (60 acres). Part I, Regional Analysis - Soils describes these soils associations completely and Map 7, Appendix A locates them. Approximately 60 acres will be disturbed by construction of two (330-and 450-MW) power plants scheduled for completion in 1977 and 1982. Construction of the power plants will involve removal from production of 20 acres of soil. Powerline construction will remove 150 acres and another 55 acres (by 1990) will be lost to population expansion generated by increased mine and power plant employment. Increased recreation use resulting from population increases will cause soil compaction, increase soil runoff and erosion. The remaining 362 acres disturbed by powerline construction will be rehabilitated and revegetated.

Alteration of Donkey Creek to allow mining may create additional onsite and offsite impacts. Streamflow will be altered increasing velocity and causing increased soil erosion and sedimentation along the stream banks. Some areas may be deprived of soil moisture thereby affecting soil productivity and vegetative growth.

Emissions from the power plants (particulate matter-sulfur dioxides) may cause soil pollution in areas downwind or to the east or southeast of Wyodak. The effect of emissions of this type, on soil has not been adequately assessed.

Mineral Resources

The most important impact is the one on coal. The removal and consumption of an estimated 165.4 million tons of coal from this area over the expected 38 year life of the mine will result in depletion of a nonrenewable energy source.

Some coal will be lost from production in the mining process, mostly by leaving fenders of coal to block spoil piles from working faces. This loss of coal is temporary and the subsequent impact minor as this coal can be recovered before the pit is abandoned.

Water Resources

Ground water

During mining and reclamation

Mining of a total of 165.4 million tons of coal over the life of the project (38 years - 2012) and removal of 3.2 million cubic yards of overburden will destroy aquifers located within the area.

Due to the great thickness of the coal mined and the relative thin overburden, the backfill will not return the mined area to the original surface altitude and residual holes will remain. Depths of the holes will be approximately the same depth as the coal thickness. After mining is completed, these holes will fill to a level approaching the water level in the nearby aquifers from groundwater discharge and surface runoff. Because the coal and the overlying rocks that are disturbed are discharge areas, recharge to the aquifers will not be affected. The area disturbed by mining operations will be very localized and should not be greater than the original pit.

Pumping for dewatering during mining operations and for consumptive use will lower water levels to the base of the coal in the pit. The cone of depression from the point or points of pumping will extend outward to an estimated six to seven miles. At the outer edge of the cone of depression, water levels will be lowered insignificantly. Within the area of influence caused by pumping, water levels will be lowered at increasingly greater depths toward the mine area. Water wells and springs that derive water from shallow aquifers within the area of greater depression may also dry up. Where the aquifer is discharging into a stream, total flow could also be reduced. Reduction in water levels could impact agricultural use and wildlife populations. Figure 2 shows the extend and amount that water levels will be lowered during mining operations.

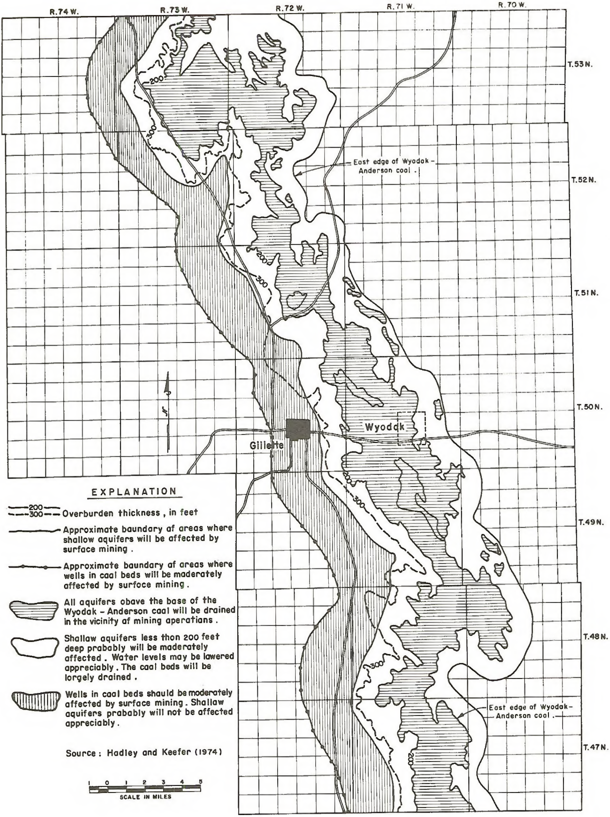


Figure 2

Potential Areas and Amounts of Lower Water Levels - Wyodak

The mined area is a discharge area and thus no change in groundwater recharge will occur. Discharge of water may be more apparent because water formerly lost by evaporation from seeps and springs and from transpiration of plants along stream drainages will be more readily discharged into the mine pits. As mining progresses, abandoned pits will receive water from groundwater discharge and precipitation and runoff. Discharge of water from ponds or lakes by evaporation will be considerable, however, because of the semiarid climate of the region.

After reclamation

Aquifers affected will be local, restricted mostly to the area where the coal was removed. Backfilling will be along the edges of the pit to cover the coal and prevent natural combustion of the coal. Water levels will return to premining levels and the chemical quality of the water in nearby aquifers will be unchanged from the original quality. Recharge will not be affected. Discharge will increase somewhat because of decreased load upon the underlying artesian aquifers. Discharge into the abandoned mine pits will be facilitated because water lost to evapotranspiration before mining along valley lowlands, will be reduced as water is discharged more readily into the mine pits.

Surface water

After reclamation

A loss of water from Donkey Creek will result from seepage to the pit. Mean annual flow will be decreased, however peak flows will remain virtually unaffected unless the dikes are breached and the flow fills the mine pit. Mining activities will result in minimal surface runoff change from the lease area, as 40 percent of the lease area presently drains to closed basins. When

the 60 percent of the lease area which drains to Donkey Creek is disturbed by mining activities, annual yield from the area will be reduced because of precipitation captured by the mine pits. The rate of runoff will be slowed due to subdued relief resulting from stripping the overburden.

Channelizing Donkey Creek may cause increased flow velocities, resulting in accelerated erosion of streambeds and banks. In changing the course of the stream, its base level may be lowered, resulting in headcutting of tributaries. Release of production waters, including mine drainage, would alter flow characterititcs, possibly resulting in accelerated erosion of streambeds and banks. Depending on the amount of release, increased erosion and sedimentation could extend several miles down stream.

Water quality

Ground water

As the mined area is a point of discharge, reduction of quality of water in the aquifers will not occur while mining is taking place. After spoils have been returned to the pit, leaching could occur which may reduce the chemical quality of water in the aquifers. Leaching of mineral constituents and possible toxic trace elements will occur where water infiltrates through the backfill. In time, this ground water will be discharged at some place either as seeps or springs along drainages or as groundwater discharge into the pit or Donkey Creek. As the water moves from recharge to points of discharge, recharge from additional infiltration through undisturbed rocks will dilute the higher mineralized water so that the increase in mineralization of the water at discharge areas could be insignificant.

Water in the residual ponds or lakes will be similar to a mixture of the ground water discharged into the pond or lake from aquifers and the water

that runs into the pond or lake from surface runoff. An increase in mineralization of the water will occur as water is evaporated leaving the minerals in the water behind.

Surface water

Erosion and sedimentation will be increased during construction and operation of the mine as vegetation is removed. High sediment yields will occur from spoil piles until they have been reclaimed and a protective grass cover established. A major portion of the water in Donkey Creek during low flow periods is sewage effluent from Gillette. Although water discharged from Wyodak may be lower in dissolved solids concentration than the water in Donkey Creek during some periods of low flow, any dissolved solids in the discharged water will increase the dissolved solids load in the stream. Increased erosion and sedimentation could lead to a lowering of water quality in the streams.

Dissolved solids load in water downstream from the proposed mining site will increase during mining and reclamation, but changes in dissolved solids concentration will depend on the amount and concentration of water in receiving streams. Dissolved solids concentration in runoff from newly exposed surfaces will increase. Continuance of the increased dissolved solids loading in downstream waters after reclamation is completed will depend on the degree of success achieved in the reclamation effort to protect exposed surfaces from leaching and erosion.

Increased population associated with mine development could affect water quality through recreational use of the area and from adding additional untreated sewage to the waters in the area.

Vegetation

Impacts on vegetation by coal mining are presently occurring. To date, approximately 120 acres of the inland saltgrass-western wheatgrass community have been destroyed by surface mining in the north and south pits of Wyodak's coal mine. An additional 20 acres have been totally or partially destroyed by roadways, the Neil Simpson Station, and related facilities.

Destruction of vegetation will be accelerated in 1977 with completion and activation of the new 330-megawatt (MW) coal-fired, air-cooled power plant and its requirements for additional coal production. Acreage destroyed by mining and processing of coal is expected to increase from the present 5 acres per year to 18 acres per year in 1977 when coal production reaches 2.5 million tons per year. According to the mining plan, coal production will be doubled to 5 million tons per year in 1982. This will increase vegetation loss to 36 acres per year.

Construction of the new 330-MW powerplant, scheduled for completion in 1977, will disturb 30 acres of the inland saltgrass-western wheatgrass vegetation type. Two new 230-kv powerlines will be constructed in connection with the new powerplant. One line will be constructed to Buffalo, Wyoming, the other one to Spearfish, South Dakota. Approximately 44 miles of these lines will be located within the study area. An estimated 1,012 acres of vegetation will be partially or completely disturbed during construction. Vegetation types which will be affected along the route have not been surveyed in detail but would consist mostly of big sagebrush-grass types.

Projected rates of coal production and estimated coal reserves indicate that the mine life will last 38 years or until 2012. Destroyed vegetation by 2012 will total 2,080 acres on the actual mine area, of the types described in the descriptive section of this part. Another 30 acres of vegetation adjacent to the lease area will be disturbed by the construction of the 450-MW powerplant in 1982.

Construction of the two new power plants will permanently remove 20 acres of vegetation. The access roads and tower footings required for the powerline will permanently remove approximately 150 acres of vegetation. Population expansion associated with increased employment at the mine and power plants will require permanent removal of 55 acres of vegetation by 1990. An estimated 900 acres or 43 percent of the total vegetative area within the mined area will be lost permanently because of the lack of fill to completely reclaim the area. Increased recreation use, especially any increase in off-road vehicle use, will impact an undetermined acreage of vegetation.

Haul road dust and coal dust from coal mining, blasting, processing and transporting, together with particulates and toxic chemicals from powerplant stack emissions will be deposited on vegetation adjacent to and downwind from the mine and powerplant. These toxic chemicals may damage vegetation when wetted by dew and light rain. Dust and particulate covered and damaged vegetation would also be less palatable to livestock and wildlife.

The use of herbicides for maintenance of power line rights-of-way would cause mortality of target species as well as short-term damage to non-target species. Drift off the target area could cause damage to additional undisturbed vegetation.

Suitable vegetation may be difficult or impossible to reestablish on some of the mined area. Toxic or nonproductive material may be brought to the surface. Microclimate will be changed. Soil structure will be destroyed with loss of some topsoil. These effects of mining may individually or in combination make revegetation difficult or impossible in some areas. With the type of climate and existing soil types in the area, prediction of reclamation success is sketchy. However, an assumed reclamation success in this area is explained in Chapter III, Part I, Reclamation of Mined Lands.

Young vegetation from reclamation will attract wildlife which like to graze on new, young shoots. This grazing will inhibit early growth and revegetation of the disturbed areas.

Archeological and Paleontological Values

No report of a professional archeological survey has been made on the Wyodak lease. A statement has been made that no archeological values exist.

With the unknown archeological-paleontological values, there could be significant impacts from stripmining. There will be nearly 2,080 acres involved in stripmining on this lease. Approximately 3.2 million cubic yards of overburden will be moved to mine the coal. Additional area (20 acres) will be occupied by construction of two additions to the existing power plant. An interstate highway (I-90) also will cross the bottom of the lease, permanently covering more land in the area of the lease. Moving the overburden or establishing permanent structures will either destroy potential archeological sites or make them unavailable for study and salvage.

Besides the direct impact of mining, there will be some indirect impacts associated with the population increase (1,100 by 1990) expected to be generated by construction and operation of the mine and power plants. The increased mine related population will permanently remove and disturb additional acreage (55 acres by 1990) which could possibly contain archeological values.

Recreational use associated with this population will impact known as well as unknown archeological sites throughout the study area. Arrowhead hunters, rock collectors, pot hunters and off-road vehicle users will all disturb additional surface acreage, destroying evidence which could provide information on archeological sites.

Historical Values

No historical values will be impacted by this action.

Aesthetics

Mine operations will impact the elements of form, line, color and texture, which combine to make up the resource termed aesthetics. Disturbance of vegetation, removal of overburden and creation of new land forms cause a change in the appearance of the landscape.

Constrasts in color will be created by stripping away the vegetative cover and overturning the soil material. The predominant color tones now seen on the area are light browns and greys. Mining will create colors of yellow and light greys which will differ from the color of the surrounding area, creating contrasts.

Texture as created by vegetative patterns and degree of erosion will be changed. Smoothing of spoil piles and reclamation with grasses will create a smoother and softer textured appearance. The new texture created on the lease area will contrast with the roughened and broken texture present on the surrounding areas. The change in texture on the lease area will result in less variety and natural configuration in the landscape. It will create a monotonous scenery, at least on the area that is mined.

Development of the transmission lines will add new lines to the landscape. These lines may cut across existing natural lines such as pipelines, and cultivated areas. Creation of new lines on the landscape could develop a jumbled, disorganized, unnatural like landscape which could be displeasing to the viewer.

New intrusions such as powerlines and power plants will be added to the landscape. These could cause development of a discordant character appearing out of place when viewed against the backdrop of a natural, undisturbed landscape. Housing which will be needed to meet the demands of expanding population associated with mine employment could add other intrusions to the study area.

Land form will be altered. A general lowering of the elevation of the mined area will take place. Abrupt breaks and changes in topographic relief will be smoothed out at completion of mining. The major change will be the remains of the highwall and creation of a lake, at completion of mining activities. These will add a new topographic break and depression where none have appeared before.

During the life of the mine, the entire operation will be exposed to direct view from the existing highway and also from the interstate highway to be constructed across part of the area. This impact will not be appreciably different from the existing mine and power generating operation. Impact on aesthetics will take place gradually over a period of time. Intrusions will be added to the landscape prior to and at the beginning of mining. Other changes will take place over a period of 38 years, the projected mine life. The changes to take place on this one site are not significant when compared to the 4.9 million acre study area. However the impact of mining on this specific site could be very significant when viewed against the back-drop of the surrounding natural landscape.

Wildlife and Fish

All wildlife will be displaced from the area as mining progresses. The smaller wildlife (reptiles, amphibians, invertebrates, rodents, and other burrowing animals) which are not able to flee will be destroyed. The populations which are displaced such as the estimated 25 antelope, a small number of sage grouse, plus numerous birds and small mammals will have to relocate on adjacent sites. It is assumed that the surrounding areas are already supporting populations in balance with the available habitat. Therefore, the displaced wildlife may exist for awhile, but the populations will eventually be lowered to remain in balance with the available habitat unless mitigating measures are taken. Part, if not all, of the displaced population may eventually be lost. The aquatic habitat associated with Donkey Creek will be lost.

Loss of wildlife habitat will be a constant progression across the mined property. Once full production of 5 million tons per year is reached by 1982, an estimated 36 acres of vegetation will be destroyed annually. By the end of the mine life, a total of 2,080 acres of habitat will have been destroyed on the mine property. In all probability, the increased human activity and noise associated with mining operations will disturb and cause the major wildlife species to leave the area prior to destruction of the habitat.

Habitat for the big game species (deer and antelope) and for sage grouse will be lost for a long period of time even though the area will be reclaimned. The projected time periods for return of the area to suitable habitat for various wildlife species groups is graphically shown in Figure 7, Chapter V, Part I. Some of the animals, especially those associated with a grass habitat (Richardson's and thirteen-lined ground squirrels, prairie dogs, mice, and other small rodents) will return to the area as it is reclaimed and

vegetation reestablished. No satisfactory evidence is presently available which would suggest that stripmined areas can be satisfactorily revegetated with plant communities that will satisfy needs of deer and antelope.

Powerline construction which accompanies the 1977 power plant will disturb 1,012 acres, permanently removing 150 acres, mostly of sagebrush vegetative type. The lines will also pose an additional hazard to wildlife (es (especially raptors) through potential electrocution.

The use of herbicides for maintenance of powerline rights-of-way could impact additional wildlife habitat on the entire 1,012 acre corridor.

Creation of a lake at completion of mining will permanently remove 900 acres of terrestrial habitat. An aquatic habitat will be substituted. Depending on water quality the impact of providing additional water surface in this semiarid climate could be beneficial.

Increased population associated with enlarged mine and powerplant operations will remove additional vegetation. By 1990, with a projected population of 1,100, 55 acres of habitat will have been permanently removed.

With increased vehicular use of the area and on surrounding roads, animal road mortality will increase. Mortality will also occur from train traffic. Construction of right-of-way fences and fences to protect the reclaimed area to allow for revegetation to be established may cause some impact on wildlife movement and migration.

Threatened species

Black-footed ferret

Loss of 2 prairie dog colonies and other small mammals will further reduce overall potential habitat available to the black-footed ferret. Such destruction in association with habitat losses occurring in other areas can

only increase the threat to this species. Loss of habitat is the greatest danger to this endangered mammal. It is not known if any black-footed ferrets inhabit these towns; none have been sighted since the mine has been in operation.

Peregrine and Prairie Falcons

Although noise and disturbance eliminates lands as suitable habitat for these species, no significant overall impact is anticipated.

Big game

Pronghorn antelope

Virtually 100 percent of potentially disturbed lands are antelope habitat. Approximately 1,480 acres of yearlong habitat in addition to 600 acres of winter range will be lost or severely damaged. Probable conversion of large acreages to aquatic habitat and increased stress through intensified human activity will dispiace an estimated 25 antelope.

Mule deer

Impacts to mule deer, a marginal species in the area, will be low.

Other mammals

Predators and furbearers

Initial impacts will be severe. Coyote, red fox and bobcats will experience less immediate impact due to their wide ranging nature. Direct habitat removal will initiate a decline in populations of raccoons, skunks and badgers. Loss of prey species will especially impact the less wide-ranging species such as badger.

Any future increase in suitable aquatic and riparian habitat might eventually enhance the area for use by raccoons, striped skunks and other predators.

Rabbits and hares

Jackrabbits and cottontails will initially undergo habitat losses as mining operations proceed. This will result in population declines. Where aquatic habitat is not developed and rehabilitation results in a reestablishment of herbaceous cover, some population recovery may be relatively rapid within new habitat capacities.

Rodents

Overburden removal during coal development will eliminate prairie dogs on this lease area. Surrounding areas are already occupied at the greatest densities they are capable of supporting and successful lasting relocation is highly unlikely. There are probably several hundred prairie dogs inhabiting the lease area.

Substantial losses of other small mammals will occur during mine operations in areas cleared for stripping, equipment work areas, and habitat conversion areas. Rapid re-colonization of suitably reclaimed areas will occur due to the high reproductive rates of most small mammals.

Upland game birds

Destruction of suitable habitat will eliminate upland game bird use. Removal of sagebrush will eliminate sage grouse use for at least the duration of the study period. An estimated 1,000 acres of sage grouse habitat will be lost. This amount of habitat provides seasonal habitat for a small number of sage grouse. Reoccupation of the lease area by game birds will depend on individual tolerances to disturbance and amount of suitably reclaimned habitat available.

Waterfowl and shorebirds

Impact of the proposed action on waterfowl will depend on acreage, depth, character of shoreline, other uses, and water quality of undisturbed habitat. Development of new aquatic habitat may enhance waterfowl habitat far beyond its present capability.

Other birds

The information available is not sufficient to allow a good assessment of impacts on birds. Refer to Chapter V, Part I of this EIS. Disturbance from increased human and mechanical activity plus elimination of forage or prey species will sharply reduce use by raptors in the area. Nearly all mobile species will avoid the lease area during periods of noise and disruption.

Fish

Development of water storage structures or "lakes" could provide fish habitat where none presently exist, provided adequate water quality is present.

Reptiles, amphibians and invertebrates

Since most reptiles and amphibians do not readily migrate from disturbed areas, there will be direct population losses resulting from elimination or drastic modification of habitat.

Invertebrates

Permanent loss or change of habitat through mining and construction of facilities will result in a direct loss of invertebrates.

Recreation

Coal stripmining and the attendant activities will diminish some hunting resource values. Nearly 2,080 acres will be mined during the life of the mine (2012). Useable terrain, habitat, and esthetic qualities associated with this acreage, while hunting, will be lost on the lease. Less than 100 hunter days are estimated lost by mining this lease; however, due to the disturbance of all related activities, nearly 200 hunter days may be lost around the area near the lease.

Mining five to ten miles from Gillette will impose an inconvenience for many who must hunt close to the city. Mining activity will disturb wildlife, affect some access to private land previously hunted and generally require residents of the area to travel 30 to 40 miles more for hunting. On the Wyodak lease, some state land (320 acres) will become physically and legally more isolated by mining and reduce some recreation base within the vicinity of Gillette.

Agriculture

Livestock forage

Mining will remove 2,080 acres of grazing land from production over a span of 38 years. This removal of land surface for mining, construction area, plant sites, etc., is the major impact to livestock grazing.

Nineteen hundred and sixty acres of native range and seeded range furnishing 530 animal unit months of forage will be removed from production. One hundred twenty acres of hayland producing 60 animal unit months of grazing will be removed from production. Creation of a lake would permanently remove 900 acres (243 AUMs) from production.

Four reservoirs and one well will be destroyed by mining activity. Donkey Creek, which is used for livestock water, will be subject to open pit mining. Water bearing toxic mine wastes may enter the well and Donkey Creek polluting underground and surface water. The loss of water will adversely affect distribution of grazing livestock. Polluted water sources may result in death of livestock.

The water in Donkey Creek may carry high levels of toxic material if fly ash is disposed of in the mined pit and the pit is allowed to overflow into the creek.

Considerable acreage denuded of vegetation during construction and mining will produce areas that are potential sources of dust contamination. Mining activity will create coal dust. This dust may be severe enough to curtail plant growth. It will probably affect forage quality and be a health hazard to grazing livestock.

Invader species of plants will become established on spoil piles. This may include undesirable plants such as those classed as noxious or others that are toxic to grazing livestock.

Hazards to livestock will be created by highwall areas surrounding pit mining areas.

Wildfires may be started by construction activities. These fires could burn forage outside of the coal lease area.

Residual particulate matter from power plant emissions will be a source of contamination to forage in the vicinity of the power plant. This will probably affect forage quality and may also be a health hazard to grazing livestock.

Farming

One hundred twenty acres of hayland and about 50 acres of land that is used for production of small grain, producing 110 tons of hay and small grain yields of barley and wheat averaging 30 bushels per acre, will be permanently lost for growing crops.

Mining activity will produce large denuded areas that will contribute some amount of blowing soil particles and coal dust. This may have an undesirable effect on the growth of crops.

Fences will be destroyed by mining activity, allowing livestock to drift onto and destroy growing crops.

Access to cropland may be destroyed, making it difficult to care for and harvest crops.

Residual particulate matter from power plant emissions may be a source of contamination to crops in the vicinity of the power plant. This may affect plant growth.

Transportation Networks

The only county road that may be impacted by the Wyodak mine would be the one that crosses the southeast corner of the north mining area. If relocation were required it could easily be achieved with a minimum of inconvenience. No paved highways will be affected by surface mining operations. The few graded and dirt roads which will be obliterated by mining will not seriously impact travel as an adequate number of similar quality roads circumscribe the mine area and access can easily be provided to ranching and other mineral operations in the area.

Impact on the future interstate Highway I-90 from employee travel between Gillette and the mine and power plants will be very minimal. The present highway U. S. 14 and 16 will remain as a frontage road to provide access to the mine thus relieving the interstate route from most mine oriented traffic. Highway 14 and 16 appears capable of easily accommodating the increase in traffic from mine and power plant employment.

Neither the short railroad spur route to the Burlington Northern line nor the proposed electric transmission lines are expected to significantly impact or interrupt existing transportation facilities.

Socio-Economic Conditions

The primary socio-economic impacts will be those associated with increases in capital expenditures, employment, population, and income.

Estimated capital expenditure at the mine will be 10 to 12 million dollars, and 25 million for each of the power plants.

Construction of each powerplant will employ 700 people for two to three years prior to facility operation.

The following table shows estimates of employment, population, and wages induced by the mine. An average annual income of $14,000 by 1980 is expected.

	1977	1980	1985	1990
Mine employment*	20	35	70	70
Power plant employment*	50	60	90	90
Other employment	142	193	325	325
Total population	500	670	1,100	1,100
Wages from mine and power plant employment only* #	$980,000	$1,330,000	$2,240,000	$3,360,000

*Does not include 1970 employment

#Assume inflation = 5 percent per year.

The mine operation will continue until about the year 2012.

Increases in population will increase the demand for services, protection, water supplies, sewage disposal facilities, and housing. Problems associated with more dense populations such as crime, mental illness, and unemployment may increase. These impacts are discussed in Chapter V, Part I.

CHAPTER IV

MITIGATING MEASURES

Air Quality

All activities having an adverse effect on air quality must comply with state and federal air quality standards (Part I, Chapter VI). Stipulations will be included in the approved mining plan requiring such compliance. Other stipulations will be included as appropriate.

Watering of haul roads in the mining area, dust-control measures incorporated in the design of crushing, storage and loading facilities, and enclosed conveyors in the secondary crushing plant will be used to reduce coal dust emissions. Control devices will be used on vehicles, equipment, and power-plant stacks to reduce gaesous and particulate emissions.

Coal fire occurrence will be reduced by keeping the area free of piles of loose coal. Use of fire prevention campaigns will minimize the frequency of fires. Firefighting equipment will be required on the site.

Immediate revegetation (topsoiling, seeding, and fertilizing) of spoils will be used and this will reduce short-term air pollution from blowing dust. Storing of initial topsoil and initial boxcut overburden with rough and uneven surfaces will reduce the amount of windblown dust.

Topography

The mining and reclamation plan filed with the Federal Government, in conjunction with federal regulations, state laws, and the coal lease terms, requires actions to mitigate adverse topographic effects of surface mining. Spoils will be graded to a rolling topography, with no slopes greater than 3:1. The highwalls will be reduced. The final pits will be filled with material from adjacent spoil banks and highwalls. The spoil banks, highwalls, and final cuts will then be covered with a layer of soil material to facilitate revegetation. All exposed coalbeds will be covered by at least three feet of soil material.

The restored land form shall be determined by consultations among the lessee, the appropriate land management agency, the State Lands Commission, and the U.S. Geological Survey. Such consultations will be frequent enough so as not to impede the progress of the mining or reclamation. Prime consideration in grading and shaping shall be catching and holding of waters falling on the area to improve the water table and catching and holding sediment in such a manner as to protect downstream areas from excessive sedimentation.

Surface water may accumulate selenium, arsenic, and other toxic elements including deleterious salts which become concentrated and deposited along the shore due to evaporation of closed water bodies. Therefore, during the shaping of the spoil into the final landform, no closed interior ponds should be permitted to form.

Soils

Impacts to soils can be minimized by including stipulations in the authorizations granted by the Federal Government.

The application of certain land treatment practices will minimize loss of topsoil and productivity, disruption of physical, chemical, and biological properties, soil loss by wind and water erosion, and compaction. Mitigating measures will include: (1) Stockpiling of topsoil for later replacement on disturbed areas, cuts, and fills. Mechanized equipment such as scrapers will be used to minimize soil mixing. (2) Ripping and cultivating the soil surface prior to seeding will minimize soil compaction effects. Restriction of unnecessary off-road vehicle use by equipment operation and employees will minimize soil compaction. (3) Soil erosion will be minimized by mulching, revegetation, and development of water erosion structures including water bars, terraces, contour furrows, grassed water ways, and intercepted ditches to divert running water away from unprotected disturbed areas. Wind erosion will be minimized by roughing up smooth exposed soil surfaces with a disk, harrow, or similar equipment immediately after clearing is completed.

Detailed soil inventories will be provided by Wyodak prior to construction. The inventories will be conducted in accordance with standards designated by the Bureau of Land Management to map and identify each soil series situated within the lease area. Soil samples will be collected to a depth of 60 inches or bedrock for physical and chemical analysis. Chemical tests will include organic matter, pH, exchangeable sodium percentage, boron, sodium, chloride, calcium, selenium, nitrogen, phosphorous, potash, sulfur, base saturation, cation exchange capacity, conductivity. Physical tests will include standard soil mechanical analysis and engineering properties. Soil mineralogy and moisture

relationships will be determined. Additional soils information will be collected after topsoil has been replaced and before seeding to determine profile, chemical, mechanical, and mineralogy changes in upper 60 inches.

Samples from overburden formations down to coal seam will be collected for chemical tests to determine presence or absence of toxic or undesirable elements or material.

Results from current or past research studies on revegetation and reclamation of disturbed areas will be applied in treating the disturbed areas onsite and offsite.

Construction designs will include mechanical treatment practices such as contour furrows, terraces, and mulching to retain moisture onsite to benefit revegetation and reduce soil loss. Design will include control measures such as diversion ditches, water ways, and water spreaders to reduce sediment yield and runoff from compacted areas or concentration of runoff waters. Studies and investigations are necessary to identify productive downstream soil units that are presently sustaining desirable vegetative communities from being deprived of soil moisture.

Disposed areas for solid and liquid wastes will be located upon sites that will not have detrimental effects upon the environment and in accordance with state and federal regulations. Service haul roads; material sites for sand, gravel, ballast; campsites; and equipment storage areas will be cleaned up, scarified, and rehabilitated to near natural condition and revegetated. The edges or vertical sides of all excavated material sites and borrow areas will be sloped to a minimum 3:1 slope to minimize sloughing and enable revegetation. Contingency plans must include measures to clean up accidental spillage of

detrimental or toxic materials such as gasoline, oils, and chemicals and restore damaged soil to a near natural condition.

Service and haul roads that are susceptible to producing dust and sediment will be surfaced or treated with a binder of water. Chemical binders, herbicides and surfacing materials must meet state and federal approval.

Study plots will be established at selected locations around the power generating plants to measure the effect of emissions upon the soil chemical and physical properties. Samples will be collected from selected plots before emissions begin to relate potential changes in soil properties.

Water Resources

<u>Retention of mines for fishing ponds</u>

After the coal has been mined, two types of landforms are possible. The overburden could be redistributed to provide a landform similar to the surrounding area, or the banks of the pit could be sloped to form a lakebed. Abandoned strip pits in Sheridan County have been successfully used to spawn smallmouth bass since 1964 (Dexter 1974).

The conversion of the Wyodak mine to a lake suitable for fish habitat would have problems of water supply. As explained in an earlier section, the surface waters of Donkey Creek are not available for impoundment. The pit would have to be initially filled using ground water or imported water. Once the pit was filled, Donkey Creek could be diverted to flow through the lake area.

The estimated ground water contribution and precipitation will be insufficient to fill the pit after considering losses due to evaporation. In addition, the dissolved-solids concentration of ground water in the pit could exceed 6,000 milo grams/liter due to evaporative concentration. Therefore, another source of water would be necessary to fill the lake.

<u>Availability of water from deeper aquifers</u>

Water-well supplies affected by lowered water levels in the radius influenced by dewatering for mining could be replaced by deeper wells. The chemical quality of water in the Fort Union Formation is similar or of better quality than water in the overlying Wasatch Formation.

Monitoring programs

Monitoring programs are being established by companies planning to mine coal. A number of the monitoring programs are being planned in consultation with the Water Resources Division of the U.S. Geological Survey. The programs consist of establishing observation wells to determine water-level fluctuations in the coal and the overlying overburden. Water samples will be collected to determine the chemical quality of the water for detecting changes in water quality after mining begins. As mining progresses, observation wells will be established in backfill areas to monitor for leaching and movement of toxic materials.

Vegetation

The loss of vegetation on land disturbed by coal mining, powerplants, and related activities will be mitigated by satisfactory revegetation. Initial measures will be started within one year following reshaping of the land and replacing of topsoil. Revegetation efforts will continue until a satisfactory stand of vegetation is established that will grow without irrigation.

Plans to revegetate the disturbed land will be approved by the administering agency. Stipulations will be developed and included in the mining plan to meet the revegetation objectives. Additional stipulations that will be considered and included in the approved mining plan are listed below.

Damage to native vegetation will be minimized by maintaining the acreage of disturbed areas (powerline right-of-way, railroad spur right-of-way, roadways, coal processing and transporting facilities, buildings, etc.), to an absolute minimum.

Deposition of dust, coal dust, and harmful chemicals on vegetation will be reduced by watering haul roads and installation of dust suppression controls on mining, transporting, processing, and loading equipment.

Completion of a detailed vegetation survey by Wyodak would provide protection for important plant communities on or adjacent to the coal property. Little information on vegetation is presently available for the area.

Archeological Preservation

Legislative authorities and obligations which guide issuance of federal license to develop the Powder River coal resources are the statute commonly referred to as Antiquities Act of 1906 (34 Stat. 225, 16 U.S.C. 431-433); Wyoming statutes relating to archeological and paleontological sites (sections 36-11 to 56-13 and 18-330.7 W.S. 1957); an act for salvage at reservoir sites (74 Stat. 220; 16 U.S.C. 469-469c); an act for historic preservation (80 Stat. 915, 16 U.S.C. 470-470m); National Environmental Policy Act of 1969 (83 Stat. 852, 42 U.S.C. 4321 et seq); and Executive Order 11593, May 13, 1971 (36 F.R.-8921).

Both federal and state antiquities acts regulate antiquities excavation and collections, and both protect historical values on public lands. They provide for fine and/or imprisonment for violators of their provisions. The reservoir salvage act provides for recovery of historical and archeological data from areas to be inundated by certain water impoundment, as a result of federal action. The Historic Preservation Act established a system of historic preservation in the nation and requires that certain federal undertakings be submitted for review by the National Advisory Council on Historic Preservation. NEPA states in Section 101(b)(4) that one objective of national environmental policy is to "preserve important historic cultural and natural aspects of our national heritage and maintain, wherever possible, an environment which supports diversity and variety of individual choice." Finally, Executive Order 11593 affects federal agencies most intimately in that they are instructed to cooperate with the nonfederal agencies, groups, and individuals and to insure that federal plans and programs contribute to the preservation and enhancement of nonfederally owned historic and cultural

values. Agencies are directed to inventory, evaluate and nominate properties in their jurisdiction to the National Register of Historic Places.

Under the mandate of the Executive Order, federal agencies must insure that until inventories and evaluations are completed, the agencies will use caution to assure that federally owned properties which might qualify for nomination to the National Register of Historic Places are not inadvertently transferred, sold, demolished or substantially altered and that federal plans and programs contribute to the preservation and enhancement of non-federally owned sites.

The Antiquities Act of 1906 prohibits damage or excavation of plant and animal antiquities on federal lands without a permit (see 43 CFR Part 3). The Wyoming statutes require that permits be obtained before excavation on any archeological or paleontological deposits on either state or federal public lands (sec. 36-11 W.S. 1957).

Archeological and paleontological values on federal lands will be protected by surveys and salvage excavations. Federal ownership of the subsurface estate extends similar protection to the federal holdings underlying privately owned surfaces. The Wyoming Antiquities Act similarly requires a permit for excavation of antiquities on public lands, permission to be granted by the State Board of Land Commissioners.

Surface surveys for evidence of archeological values in the alluvium are fundamental to establishing responsible stipulations for their protection. Therefore these stipulations in the mining plan and/or permit that require surveys will be followed to insure archeological and paleontological protection.

No mining plans or rights-of-way will be approved until the company has coordinated its archeological surveys with the Wyoming State Historic Preservation Officer (State Archeologist). Company survey reports will be submitted to the State Historic Preservation Officer with a copy to agencies approving plans and permits. The report will be certified by the Preservation Officer and forwarded to the approving agencies, with a statement that surveys have been conducted by competent, professional archeologists and a recommendation for additional surveys to be required before plans and permits are approved. These additional surveys may be necessary if surface evidence indicates further evaluation is necessary. In addition approvals will be conditioned to require notification to the Area Mining Supervisor of all archeological and paleontological sites discovered during mining prior to disturbance and notification to the appropriate officer of the surface administrating agency of sites discovered during right-of-way construction prior to disturbance. The Antiquities Act of 1906 and Wyoming statutes make it unlawful to excavate sites which are discovered without a permit.

Furthermore, it will be required that the alluvium to be displaced during the mining operation be surveyed and that all surveys be coordinated with the Wyoming Historic Preservation Officer to insure competent, professional inventories, salvage and preservation of archeological and paleontological data.

It is recommended that all present and future applicants share in the cost of establishing a full-time resident basin paleo-archeologist under the supervision of the State Historic Preservation Officer. The basin archeologist will aid in reducing lead time and development delays performing, advance surveys for support facilities, educating construction employees, sampling soils, responding to company discoveries and conducting salvage work.

Historical Values

According to the State Historian, the possibility always exists that new information may be discovered that could place value on a previously unimportant site. If this does occur, the appropriate Acts shall be used to determine the course of action to be taken by the agency having jurisdiction on the land.

Aesthetics

The Wyodak mining plan will contain stipulations guided by Departments of Interior and Agriculture visual resource standards. These stipulations will provide that construction design blend with the natural landscape, keeping a low profile with structures like silos and transmission towers to the extent possible.

Probably the most critical factor in reducing the impact of a lineal project, is location in relation to naturally occurring lines in the landscape. Lineal projects will be located where natural lines already occur, following contours and depressions and avoiding a crossing at the crest of a hill.

Topsoil will be stripped off and replaced over reshaped natural landforms. Native vegetation will be used where practical and seed is available. Plantings will be irregularly seeded to break the unnatural lines of construction. Disturbed areas will be kept to a minimum and highwalls back sloped to a maximum of 3:1. Nonreflective materials will be used on transmission lines, towers, buildings, silos, conveyors, and crushers, e.g., unpainted concrete on the silos.

Wildlife and Fish

Measures which will result in a degree of mitigation of impacts on some wildlife species are primarily those which will come about incidental to attempts to reestablish grasslands for livestock forage and watershed protection. The potential may exist to significantly improve the habitat for some species (including fish). Existing state and federal air, water, and land quality laws will insure some mitigation of impacts through broad requirements of revegetation, nondegradation of water quality, and reduction of gross air pollution. These legal authorities may reduce total and long-term impacts on fish, waterfowl, some birds, rodents, and invertebrates. They can be expected to have only slight mitigating effects on total impacts on other species.

Opportunities for mitigation of wildlife losses, as opposed to legal requirements, are available. Attempts to provide a variety of topography, reestablish shrub and riparian land ecosystems, and expand quality aquatic habitats could be expected to meet with sufficient success to reduce at least part of total long-term impacts on a variety of species. Due to the nature of mining and power plant operations and the long time-period required to reestablish these vegetative types, their mitigation would be little realized before the end of the study period.

A variety of native species representing shrub, forb, and grass groups should be well represented. Palatable varieties of big sagebrush and rabbitbrush as well as skunkbush sumac, chokecherry, and juniper would help mitigate losses of deer, antelope, sage grouse, and nongame species. Varied topography would increase habitat diversity and result in greater variety and abundance of wildlife.

Powerlines constructed as needed for the power plant and other facilities may be designed to minimize dangers to raptors and other species of wildlife.

Fencing barriers and hazards to deer and antelope movement could be reduced by using less fencing, using fences passable to antelope and deer, and using various crossing structures. These measures should be planned and located on the ground with the State Game and Fish Department as the development proceeds.

A lake(s) created as a "by-product" to development should have irregular shorelines and islands to create the maximum amount of shoreline. Some shorelines should slope gradually to provide shallow, marshy areas and encourage emergent vegetation while others should have steeper shoreline to discourage emergent vegetation, thus increasing diversity. Shallow ponds would have the greatest value for waterfowl and deeper ponds the greater value for fish.

Reestablished riparian vegetation along drainage courses and around aquatic habitats would eventually result in reestablishment of many animals associated with this habitat type (Table 11, Chapter V, Part I). Potential also exists to enhance offsite habitat which would offset losses created by mine development.

Recreation

If any requests for water impoundments are made on the Wyodak lease covering federal lands or minerals in areas of important cultural and recreation values, impact assessment and protection can be given through the authority granted by the Reservoir Salvage Act of 1960 and the National Environmental Policy Act of 1969.

If a reservoir planned for construction covers federal surface or mineral and has for its use water designated for another federally approved project, it will be assessed under the requirements of the National Environmental Policy Act and salvage requirements under the Reservoir Salvage Act. If cultural values are located, the "criteria for effect," under Section 106 of the National Historic Preservation Act and Section 2b of E.O. 11593, will be initiated by any federal agency joined in the project.

Where scenic, historic, and recreation values are impacted, either on or adjacent to federal land, it will be required that agencies constructing new federal aid highways study locations and alignments that complement these resources as stated in the Federal Aid Highway Act of 1973.

The Wyodak mining plan, in conjunction with land reclamation, will insure enhancement of any planned lakes or ponds by providing stipulations for shorelines and slopes that improve fishing and waterfowl nesting. These will improve sightseeing and hunting opportunities for area residents.

Agriculture

Livestock Grazing

Measures that may be taken to minimize the affects of mining on livestock grazing should be initiated at the appropriate stages of the mining procedure.

The coal to be produced requires about four acres annually and this figure will increase in two stages until approximately 36 acres are required annually within eight years. Temporary fences should be erected around the areas actively involved in mining so that the remainder of the area will be available for livestock use and the hazards from highwalls and mining equipment to livestock minimized.

Topsoil will be stockpiled in sufficient amount to provide for placement on spoil piles at a depth not less than six inches. This will enhance plant growth for livestock forage during required reclamation.

Where operations could result in acid or saline drainage or sedimentation of adjoining land or streams, provisions will be made for impoundments. Impoundments will not affect adjacent landowners or contribute to water pollution. Water capable of supporting fish and other aquatic life should be the goal of any impoundment. When feasible, erosion control and flood control structures should be built prior to starting excavations.

All operations will be conducted to avoid wildfire and spontaneous combustion. Open burning of all materials will be in accordance with suitable practices for fire prevention and control. Abandoned highwalls will be reduced to slopes no steeper than 30 percent.

Spoil piles will be reduced to slopes no steeper than 30 percent and topsoil spread at a depth not less than six inches and revegetated as soon as

practical. Denuded areas will be mulched and the mulch disked into the mineral material surface, on the contour pattern, to reduce runoff, erosion, and sedimentation. Adequate mulching will be maintained until revegetation specifications have been met.

Water wells to be breached will be plugged with concrete to a point not less than 20 feet below the final mine floor proposed. After spoil rehabilitation is complete, new wells will be drilled to replace those destroyed.

Metal and all other nonmineral material waste will be buried or removed and disposed of. Noxious and toxic species of invader plants will be controlled by using approved herbicides. The owner will be reimbursed at the appraised price for the loss of all facilities destroyed by mining activity.

Prepared spoil areas will be seeded with recommended seed mixtures. Seed will be drilled into the soil to a depth of 1/2 to 3/4 inch and on a contour pattern. Two years shall be a proper interval to determine if an adequate stand has been established. Two tries to establish an adequate stand will be considered adequate. Two years after an adequate stand of vegetation has been realized, the fences will be removed and the area made available for livestock grazing.

Stack particulate emissions will be treated by precipitators so that the stack emissions conform to standards. Fly ash and cinders will be buried by landfill operations. The finished surface will not have less than two percent slope to insure that surface water will not be allowed to stand over these ash burial landfills.

Since Wyodak has proposed no rehabilitation plan for the north unit, rehabilitation will be in accordance with the previous mitigating measures. These measures are essential if adequate rehabilitation is to be achieved to

make the land useable for livestock grazing. Special attention should be given to the cut and spoil bank profiles shown in Figure 1. Final shape will be smooth surface or rolling topography surface. Flat top piles will be avoided.

Farming

Measures that will minimize the effect of mining activity on farming must be adequately timed. The following measures will be considered minimal in an adequate mining plan.

Acreages to be prepared for mining should be posted one year prior to anticipated activity to prevent economic loss due to unnecessary summer fallow operations or destruction of growing crops. Written notification to operator of cropland will be sufficient.

No less than one access route will be maintained to each cropped field. Temporary fencing will be installed to protect crops from destruction by drifting livestock when permanent fencing is destroyed by mining activity.

Active highwall areas will be posted with hazard warning signs. Abandoned highwalls will be sloped to a grade not exceeding 30 percent. Abandoned spoil piles and denuded areas will be mulched to reduce accelerated erosion and sedimentation due to wind or water. The mulch shall be disked into the mineral material surface. Active areas, such as haul roads, will be treated to reduce windborn mineral particles to an acceptable level.

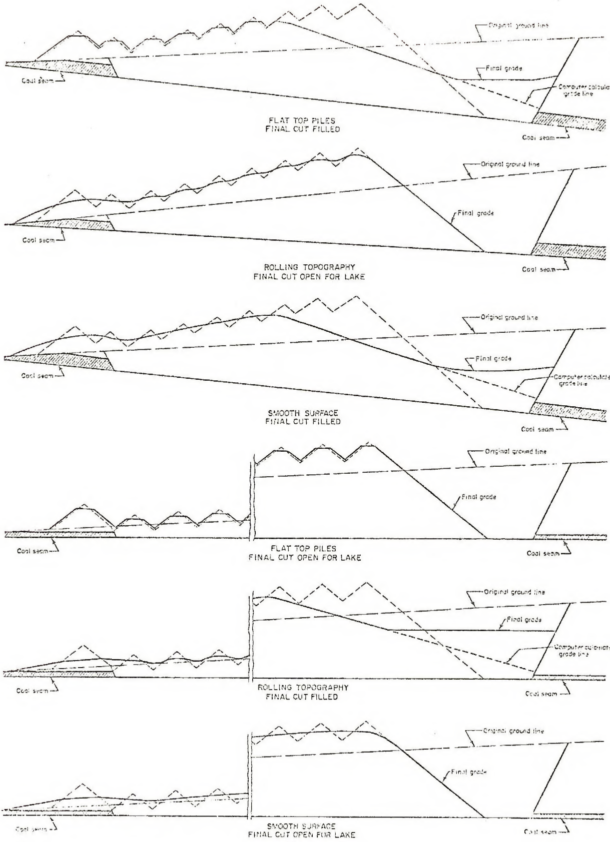


Figure 1

Typical Cross Sections of Graded Spoil From Six or More Cuts

Transportation

To mitigate impacts on traffic flow due to highway relocation, it will be necessary to allow traffic to travel undisturbed over the existing road until the realignment is completed. It will be necessary to provide alternate routes of access to any ranching or other local operations that will be isolated due to obliteration of roads within the mining lease.

CHAPTER V

PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Air Quality

Adverse impacts on air quality resulting from development of the Wyodak mine property cannot be avoided. Some coal and soil dust created by mining 165.4 million tons of coal, disturbing a total of 2,952 acres (1,940 mined - 1,012 powerline construction), over the 38-year period will occur. About 36 surface acres will be disturbed in any one year and 100 acres may be bare at any one time.

Even with proper emission controls, emissions from vehicles, equipment, and accidental fires will occur, causing a reduction in air quality on the lease site and downwind.

Construction and operation of the new 330-MW power plant (plus conversion of unit 5) will add some additional particulates, sulfur dioxide, and nitrogen oxides to the atmosphere. However, operation of the new plant in 1977 with proposed emission controls will reduce present particulate emissions by over 600 tons per year (Table 1). With construction of the 450-MW plant by 1985, emissions will increase again. These are given in Table 1, assuming emission controls, and shows cumulative emissions in 1985 that would be unavoidable.

Stack emissions of pollutants, including trace elements, cannot be completely controlled with existing technology so some adverse effects on air quality will be unavoidable. However, with planned controls ambient air quality standards are proposed to be met. Table 2 compares the projected unavoidable stack emissions with the 1970 quantities for the Wyoming Intrastate air quality control region.

Table 1

Predicted Emissions for Power Plants at Wyodak

Plant	Coal Requirements Million tons/year	Estimated Emissions - tons/year Particulates	Sulfur Dioxide	Nitrogen Oxides	Federal NSPS - tons/year* Particulates	Sulfur Dioxide	Nitrogen Oxides
Existing 30 MW (in 1974)	0.4**	1,518**	920**	708**	330	3,960	2,310
New 330 MW plus Unit 5 (in 1977)	1.5	840***	8,550#	8,100##	1,240	14,880	8,680
New 450 MW (in 1982)	2.0	1,080***	11,400#	10,800##	1,650	19,800	11,550
Totals by 1985	3.5	1,920	19,950	18,900	2,890	34,680	20,230

*Data based on Federal New Source Performance Standards (NSPS) for Steam Generators.

**To be retired when new 1977 plant is activated.

***Assuming 99 percent control efficiency.

#Assuming 40 percent removal in furnaces.

##Assuming 40 percent removal within boilers.

Table 2

Unavoidable Stack Emissions Versus 1970 Total Emission for
Wyoming Intrastate Air Quality Region
(Tons/year)

	1970	1985	
Type	Base	Increase	Percent Increase
Particulates	26,510	28,430	7.2%
Sulfur Dioxide	38,202	58,152	52.2%
Nitrogen Oxides	38,647	57,547	48.9%

Topography

A reduction in altitude caused by mining thick beds of coal with thin overburden cannot be avoided. The decrease in altitude over the lease area will range from a maximum of 103 feet to a minimum of 24 feet. Average drop will be about 77 feet.

Destruction of natural features of the landscape is unavoidable. Even though the general topography of the area can be restored at a lower level, cliffs and abrupt breaks, presently a part of the topographic scene, cannot be restored. The exact slope and angle of the present topography is unrestorable.

Change in the drainage channel of Donkey Creek cannot be avoided.

Soils

Disturbance of topsoil on a total of 3,067 acres (1,940 mined - 60 power plant - 1,012 transmission corridor - 55 housing) cannot be avoided. Loss from productivity of 1,125 acres of soil (transmission line - power plant facilities - housing - lake) is unavoidable. Disturbance of topsoil will lower to some degree the natural soil productivity of the area by compaction, mixing natural soils, and causing accelerated soil erosion.

On the area to be mined, 1,940 acres, complete destruction of all soil horizons, parent material, and soil characteristics which have developed over long periods of geologic time cannot be avoided. Present soil biota and soil forming processes will be terminated. Once mining is completed and the area reclaimed, soil development will have to start again. As an end result, new soils will be formed with characteristics totally unlike the ones existing prior to mining.

Reduction of soil productivity, permeability and infiltration rates are unavoidable. Increase in erosion and sedimentation rates will occur, but amount of soil loss through time cannot be determined.

Mineral Resources

The mining and removal of coal cannot be avoided under present plans and proposals. Thus, to the limit of coal removed the proposed mining activity will have an unavoidable adverse effect on the coalbeds, coal resources, and coal reserves in that deposits of a nonrenewable mineral commodity will be depleted. Based on company plans, an estimated 165.4 million tons of coal will have been mined by 2012 which comprises 1.3 percent of the estimated economically recoverable strippable coal reserves thus far identified in Campbell and Converse Counties. Loss of minor amounts of coal in mining, loading, and transportation operations is unavoidable.

Water Resources

The amount of water consumed in mine operations will be unavoidably lost. The amount cannot be quantified. Aquifers removed by mining will be permanently lost. However, the effect of this loss will be of local extent.

Leaving the final pit as a lake may deplete streamflows and will add to evaporational loss of water which then is not available for other uses (agriculture - stream habitat).

A reduction in water quality from increased erosion and sedimentation will occur to some degree. The amount or degree cannot be estimated.

Vegetation

Vegetation will be temporarily disturbed or destroyed on 1,902 acres and permanently removed on 1,125 acres. These losses associated with mine operations, transmission line construction, increased population, and power plant construction cannot be avoided.

Reclamation of areas disturbed by rights-of-way will occur shortly after disturbance. However, success of revegetating the severely disturbed mined area is unknown at this time.

All plant succession is unavoidably destroyed at the time of disturbance. Fifty years or more of plant succession will be required for these areas to return to their present state as existing soil structure and microclimate have been changed and altered.

Even on areas that are successfully reclaimed, a 50 percent loss in productivity has been projected.

Archeological and Paleontological Values

Subsurface material and sites will be damaged or destroyed under the most responsible mining program, with much more lost to indifference from surface activities of population expansion.

Some losses, removal of 55 acres to regional expansion, will be expected from lack of surface evidence, time, money, and trained personnel to conduct regional surveys.

Limited interpretive and educational material on the collected data will contribute to uniformed damages by construction activities and regional residents.

Aesthetics

The added structures, power plants, powerlines will be discordant intrusions added to the natural landscape. The natural landscape (shape - texture - color) will be changed unavoidably. To some, this will be an adverse alteration of the natural landscape.

Even after reclamation, the disturbed areas will be discernible for a long period of time.

Wildlife and Fish

Loss of habitat and reduction in population will occur. The smaller wildlife (reptiles, amphibians, invertebrates, rodents, and other burrowing animals) which cannot flee will be destroyed. An estimated 25 antelope and some sage grouse will be displaced and probably lost.

Destruction of 1,940 acres of habitat will reduce the carrying capacity of wildlife habitat in this area. Successful return of wildlife habitat for most animals will require a period of from 20 to 50 years. (Figure 7, Chapter V, Part I). The permanent removal of 1,125 acres of habitat will be unavoidable.

Increased population will intensify recreational use of the area. This will adversely impact additional wildlife habitat.

Recreation

Loss of an estimated 100 hunter days of use per year on the site and a potential of 200 hunter days of use around the area cannot be avoided.

Reduction of wildlife habitat, population, and quality will lessen hunter opportunities. Increased population will intensify recreational use, which could cause adverse reduction of recreation quality and deterioration of facilities.

Agriculture

Permanent loss of 900 acres of forage and 243 AUMs cannot be avoided. Destruction of four reservoirs and one well is unavoidable. Reduction of livestock water will result in a loss of grazing capacity. The well may be replaced after completion of mining. The creation of a lake would mitigate loss of the reservoirs.

Temporary loss of forage during mining operations cannot be avoided. Reduction of an estimated 50 percent in carrying capacity after reclamation cannot be avoided. This will cause an annual overall yearly loss of 160 AUMs, assuming the entire area will be successfully revegetated.

The necessity of the rancher having to provide elsewhere is unavoidable. The added economic cost of the rancher having to provide new water sources for his livestock cannot be avoided.

Transportation Networks

Increased traffic on all existing facilities cannot be avoided. The increase will begin in 1975. Road maintenance costs and frequency will increase and these costs cannot be avoided.

Temporary inconvenience and poor travel conditions caused during construction of such facilities as the transmission lines are unavoidable. These impacts will be minor and occur only over a short time span.

Socio-Economic Conditions

Unavoidable adverse effects of the proposed action cannot be quantified at this level. The cumulative impacts are analyzed in Chapter VII, Part I.

CHAPTER VI

ALTERNATIVES TO THE PROPOSED ACTION

Approve the Mining Plan After Modification

Some of the impacts identified and discussed in Chapter V could be avoided if the mining plan were modified to require the use of one or more of the operational alternatives discussed below. In addition, special conditions could be added to the plan relating to secondary effects of the mining. Such conditions must be reasonable and, if unacceptable to the lessee, could result in the lessee not developing the area with the resultant impacts discussed under the heading "No New Development of Coal" and "Alternate Reclamation Objectives" in Chapter VIII, Part I.

Different methods of mining

Underground mining

Substitution of this method of mining would result in less initial disturbance of the land surface; greater costs because underground mining would be more costly than surface mining; a decrease in mine safety as indicated by the fatal accident rates in 1972 of 0.42 per million tons mined underground compared to 0.07 per million tons for surface mining; and higher incidence of nonfatal accidents due to roof and coal falls, fires, explosions, and problems related to dust inhalation (black lung disease).

On Wyodak's federal leasehold, the coalbed averages 84 feet in thickness. Assuming that a 10-foot section could be mined safely by underground methods and that 50 percent of coal in the mined area was left in place to provide support and lessen the probability of surface subsidence, coal extracted would represent about 6 percent of the available coal in place. This rate

compares to a present recovery of approximately 95 percent of the available coal in place at Wyodak.

In-situ production

Techniques for the economical burning of coal in-situ and capture of the released volatile gases are still in experimental stages. Present knowledge indicates that energy recovery levels of in-situ production are low and amount of surface subsidence in areas of thin overburden is highly unpredictable. Impacts associated with in-situ production would include the possibility of destruction of a coalbed aquifer, pollution of ground water, and air pollution from escaping gases.

For in-situ production to be a viable, alternative technique methods for increased recovery of volatile gases must be developed. Such increases could then allow in-situ production to compare favorably with the high recovery of coal by surface mining methods.

Different rate of production

Wyodak Resources Development Corporation is currently supplying 700,000 tons of coal per year to the onsite Neil Simpson power plant of the Black Hill Power and Light Company and offsite power plants in Osage, Wyoming, and Lead and Rapid City, South Dakota. The proposed new power plant expansion will require a total yearly production rate of 2.5 million tons in 1977 at which time the proposed new power plant will be in operation and will use the additional coal produced. Another power plant scheduled for completion in 1982 will handle the increased production resulting from an increase to five million tons in 1982.

Any change in production rate either upward or downward would alter the rate or intensity of the environmental impacts discussed previously in this statement. If a reduction in proposed production rate were required, it would

create a shortage of fuel at the power plants in the area of consumption, resulting in decreased power production when consumption is increasing unless substitute sources of supply were obtained. A reduction would also prolong mining activity on the leasehold, prolong the time until restoration is completed, lessen employment at the mine, lessen the acreage disturbed at any one time, and lessen annual tax and royalty returns to the state and county.

If the company were required to increase production above the level proposed, it would cause storage problems, with the possibility of fires in storage areas, unless additional new markets were found, increase the intensity and severity of the impacts described elsewhere in the statement, decrease the length of time for mining and reclamation, and increase annual tax and royalty returns.

Alternate reclamation objectives

Instead of creating a lake in the reclaimed area, an alternative is to backfill the pit area and grade it to the approximate original contour. This grading would be very difficult if not impossible because mining at the Wyodak site involves the removal of large amounts of coal (84 feet thick including a 16-inch parting) compared to an average of 30 feet of overburden. Returning to original contour would require hauling large amounts of fill material from other sources to fill the open pit. This hauling would be uneconomical as well as creating a problem of obtaining the fill material from another source. Returning only the overburden to the mined pit would leave a large depression which could create a marshy area of little value.

Different utilization

To supply coal to other offsite electrical power generating plants would have the effect of transferring transportation and other end-use impacts elsewhere.

These impacts have been described heretofore in the statement. The impacts associated with mining and reclamation would remain the same if the proposed production rate was not increased. If increased, the severity and duration of these would also be increased.

Different methods of coal transport

Pipeline transportation

Transporting coal in a pipeline as a slurry could be required as a possible alternative. An advantage would be less surface pollution by wind-blown or spilled coal from railroad cars. The time and capital cost of planning and constructing a pipeline from the Wyodak mine to the three power plants in Wyoming and South Dakota is unknown. Based on the Black Mesa pipeline, however, the cost would be in excess of $128,000 per mile (Love 1969).

Impacts of this alternative, in addition to cost, would be the securing of a pipeline right-of-way to the area of consumption at least 75 feet in width and land for in-line support facilities, the obtaining of water rights for the large volumes of water for slurry preparation and pipeline transportation, 240 gallons of water per ton of coal, the construction of water and slurry storage facilities requiring additional surface disturbance at many localities along the right-of-way, the construction of additional processing facilities at the mine to prepare the coal for transmission as a slurry, the construction of de-watering facilities, the loss of a large tonnage of steel pipe to other uses, the loss of the energy required to construct and run such a coal slurry pipeline to other uses, and the possibility of pipeline spillage and rupture which could degrade local areas.

Highway transportation

Substitution of truck haul for railroad haul would not cause additional surface disturbance at the proposed mine except in the vicinity of a truck loading facility. Existing county, state, and federal roads would have to be redesigned and rebuilt to withstand the stress of constant coal loaded truck traffic. The large number of trucks would create increased noise, pollution from truck emissions, and increased safety hazards for the public.

Reject Mining Plan

Rejection of the Wyodak mining plan would result in no environmental impact on the leased lands not already mined, and they would continue in their present condition or be modified by the surface owner to meet other uses as may be determined. Wyodak Resources Development Corporation could submit a new mining plan, challenge the rejection, or abandon--at least temporarily--development of the lease. Should the mining plan be rejected, the development of alternate sources of energy or a reduction of energy consumption would be required.

Wyodak may continue mining operations on its holdings of privately owned coal in the same locality with the same primary and secondary impacts as those evolving from the mining of both federal and private coal. Such mining would result in a number of small mines in the privately owned lands, leaving the federal coal untouched. Such a pattern, where federally owned coal is not mined, would increase extraction costs, create an indeterminate number of small, isolated strip mines on privately owned coal lands, result in increased mining problems and costs if the federally owned coal were later extracted, and result in a loss to the state and county of taxes and a loss of the state's share of revenue distributed in accordance with the Mineral Leasing Act. In addition, reclamation and enforcement requirements under state laws could be either more or less stringent than those required by the Federal Government, thereby affecting the restoration of mined areas.

In the event Wyodak chose not to mine on privately owned land as a consequence of rejection of a mining plan on the federal leasehold, the shortage of coal for the power plants would have to be obtained from another source.

CHAPTER VII

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Mining will result in the introduction of additional roads, power plants, and powerlines into an area already changed to some degree from its natural state by the existing mining activities.

The lease area will be committed to coal production for a period of about 38 years based on anticipated production levels.

As the coal is mined, the overlying soil and rocks will be removed and the affected acreage will be lost to grazing and rangeland recreation for a period of five or six years except for the permanent loss to a 900-acre body of water.

Impacts arising from the short-term use of the environment will be minimized to the greatest extent practicable consistent with modern mining and reclamation practices. Grading of spoils will reduce ridges to a rolling topography aesthetically consistent with surrounding undisturbed areas. Replacement of soil material and establishment of vegetative cover will return mined land to grazing as soon as possible following extraction of the coal.

Mining will temporarily disrupt the flow of surface water. Ground water levels may be lowered locally because of the removal of parts of aquifers in unconsolidated material, sandstone, and coalbeds. Rainwater and water flowing into the mined area will probably be retained by infiltration into the spoils, creating perched water tables.

The preceding indicates that short-term use of parts of the leasehold for mining will be accompanied and followed by a period of reclamation and

revegetation. Although the land's appearance will be permanently changed, its attractiveness should not be adversely affected. Other potential long-term land uses may be impaired by introduction of heavy industry, housing developments, and development of other resources. In addition, coal used for power generation will not be available for other uses or for future use.

Thirty-five to 100 additional acres will be disturbed by mining each year with an equal number of acres undergoing grading and planting. At any one time the total area disturbed will be about 150 acres. Since final reclamation of a particular area is estimated to lag about five years behind mining, wildlife and livestock will be displaced for at least that period of time.

In summary, the land will be used for mining coal rather than for grazing and wildlife habitat for a period of five to ten years at which time the land should be restored to its former or other designated uses.

Disturbed land, presence of heavy equipment, other mine-related facilities, and associated noise, dust, and solid waste will be only of short duration. After mining, reclamation, and revegetation are completed, the principal long-term changes will be local modification of the topography and surface drainage systems and loss or reduction of productive capacity.

It is estimated that total productive capacity of the land will be reduced 50 percent over present levels even if revegetation is successful. Reclamation techniques in this semiarid climate have to be tested before any final predictions can be made as to success ratios.

Wildlife habitat for those animals which depend on a sagebrush type (antelope-sage grouse) will be destroyed for a period of 20 to 50 years. Figure 7 in Chapter V of Part I shows the time span from point of disturbance which is required for replacement of adequate habitat for various animal groups.

Mining of this area will involve a long-term loss in productivity. Under the climatic conditions which prevail for this area, the area may never regain its present productive capacity. If water quality is sufficient in the lake, long term aquatic habitat productivity may be enhanced.

CHAPTER VIII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The major commitment of resources is the mining and consumption of 165.4 million tons of coal over the 38-year life of the mine. This loss represents about 1.3 percent of the economically strippable reserves of the Eastern Powder River Coal Basin.

Use of an indeterminable amount of sand and gravel and clinker for aggregate in the construction of power plant facilities will occur. Clinker, sand, and gravel deposits mined with the overburden and moved with other spoil will be irretrievably lost.

The only ground water aquifers that will be irreversibly committed are those aquifers that will be physically removed during mining. Adjacent parts of these aquifers will be affected during mining operations, but water levels are expected to return to normal after mine dewatering stops. The chemical quality of water in the aquifers will not be changed.

The extraction of coal and reclamation of disturbed areas will require the use of electrical power, lubricants, liquid fuels including diesel fuel and gasoline, ammonium nitrate explosives, and structural materials for construction and repair of surface buildings. Chemicals and materials used in mining and reclamation would also be lost for other uses.

Loss of life will occur both in the mining operations and associated with increased vehicular and train traffic. Based on fatal accident rates experienced in the strip mining industry during 1972, one employee will suffer a fatal accident for every 14.3 million tons of coal produced. Disabling injuries will occur at the rate of 9.24 per million man hours worked. Therefore,

during the life of the mine an estimated 12 people will lose their lives. This will be an irretrievable commitment of human resources.

Any destruction of archeological and paleontological values will be an irreversible commitment of resources.

It is doubtful that total reestablishment of the complex native plant community is possible on disturbed areas of the mined area. Strip mining and associated activities will eliminate a portion of this life-support community which is the major irreversible impact to wildlife in the area.

Wildlife resources that may be irretrievably lost include individual animals and habitats that are destroyed. Animals and plants that would have reproduced in the affected habitats during the life of the mining operation may also be irretrievably lost. Most wildlife losses may be reversible if the species and habitat are not impacted to the point that their ability to reproduce is seriously impaired.

It is doubtful that full production can ever be restored to areas severely disrupted by strip mining. The assumption has been made that even upon revegetation, productive capacity will be reduced to 50 percent of previous capacity. Until further research is conducted, this has to be considered an irreversible commitment of resources.

The annual forage production which the area could have produced will be lost during the time that mining takes place. Production could be lost on 100 to 150 acres annually. This increment of production lost is an irreversible commitment of the livestock forage.

The productive area lost to the projected 900-acre lake probably should be considered an irretrievable commitment of land resources.